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WATER SUPPLY AND WATER QUALITY CONTROL STUDY BLANCHARD RESERVOIR NORTH BALD EAGLE CREEK BASIN PENNSYLVANIA. STUDY OF NEEDS AND VALUE OF STORAGE FOR MUNICIPAL AND INDUSTRIAL WATER SUPPLY AND WATER QUALITY CONTROL

Public Health Service
Charlottesville, Virginia

May 1965

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WATER SUPPLY AND WATER QUALITY CONTROL STUDY BLANCHARD RESERVOIR NORTH BALD EAGLE CREEK BASIN PENNSYLVANIA

A survey has been made which indicates that there is an adequate quantity of water available to meet all future municipal and industrial water supply requirements within the area of influence of the proposed Blanchard Reservoir. Storage may contribute to improved quality below the reservoir; however, the inability to define the chemistry of streams containing mine drainage prevents an accurate determination at this time to establish any need for storage for stream flow regulation for quality control. Future needs are based on the results of economic and demographic studies which include projected industrial and population growth.

By

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region III
Charlottesville, Virginia

May 1965

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I. INTRODUCTION

REQUEST AND AUTHORITY

The U. S. Army Engineer District, Baltimore, Maryland, by letter dated May 1, 1962, requested the Public Health Service to make a study of water supply and water quality control aspects of the proposed reservoir development in the North Bald Eagle Creek Basin in Centre County, Pennsylvania.

This study was made in accordance with the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq), and the Memorandum of Agreement, dated November 4, 1958, between the Department of the Army and the Department of Health, Education, and Welfare.

PURPOSE AND SCOPE

The purpose of this study is to determine municipal and industrial water supply and water quality control needs which could be served by the proposed reservoir on the North Bald Eagle Creek near Blanchard, Pennsylvania, and to determine the value of storage provided in the reservoir to satisfy the needs. The area of study includes the North Bald Eagle Creek Basin and the area along the West Branch of the Susquehanna River between the confluence of North Bald Eagle Creek and the North Branch of the Susquehanna River. The future water needs in the Basin have been estimated for a period ending in the year 2020.

ACKNOWLEDGMENTS

Information and cooperation provided by the following agencies are gratefully recognized:

New York and Pennsylvania Company, Lock Haven, Pennsylvania

Pennsylvania Department of Health, Harrisburg, Pennsylvania

Pennsylvania Department of Internal Affairs, Harrisburg, Pennsylvania

Pennsylvania Public Utilities Commission, Harrisburg, Pennsylvania

U. S. Army Engineer District, Baltimore, Maryland

U. S. Geological Survey

Surface Water Branch, Harrisburg, Pennsylvania

Water Quality Branch, Harrisburg, Pennsylvania

U. S. Weather Bureau, New Cumberland, Pennsylvania

II. SUMMARY OF FINDINGS AND CONCLUSIONS

SUMMARY OF FINDINGS

1. North Bald Eagle Creek Basin, located in central Pennsylvania and a part of the Susquehanna River Basin, is bounded by the Allegheny Mountains on the northwest and the Nittany and Tussey Mountains on the south and east. The Basin is topographically divided by the Bald Eagle Mountains into two distinct areas: Bald Eagle Valley and Nittany Valley.

2. Principal communities within the Basin are Bellefonte and State College. The City of Lock Haven is located on the Basin boundary with a portion of the City adjacent to the West Branch Susquehanna River.

3. Major industries within the Basin--pulp and paper, aircraft manufacturing, and primary metals--are located in the Lock Haven and Bellefonte areas. Principal activities in Nittany Valley, which includes State College, are dairy farming and the educational and research programs of Pennsylvania State University.

4. Present municipal and industrial water uses in North Bald Eagle Creek Basin total 12.4 and 98 mgd, respectively.

5. Proposed Blanchard Reservoir would be located on North Bald Eagle Creek in Centre County, Pennsylvania, approximately 15 miles upstream from the City of Lock Haven and the confluence with the West Branch Susquehanna River.

6. North Bald Eagle Creek, at the proposed reservoir site, has a drainage area of 339 square miles. The average annual discharge, based on 10 years of record, is 465 cfs, with a minimum flow of 93 cfs, and a maximum flow of 5,900 cfs.

7. North Bald Eagle Creek, at the proposed reservoir site, is of good quality except for high concentrations of inorganic nitrogen and phosphorus. The concentrations of nitrates and phosphates range from 1.0 to 8.5 mg/l and 0.29 to 6.60 mg/l, respectively.

8. The West Branch Susquehanna River, although generally slightly alkaline, is subjected to occasional severe acid surges that are termed "slugs" caused by a downstream flushing of acid and/or acid producing materials.

9. The West Branch Susquehanna River above Lock Haven is acidic because of major contributions of mine drainage. North Bald Eagle Creek is a primary source of alkaline water (averaging 60 mg/l alkalinity at the mouth) and serves to neutralize the acid load. From 1950 to 1963, the 16 fish kills in the West Branch Susquehanna River below Lock Haven have been attributed to "slug" conditions.

CONCLUSIONS

1. The population of North Bald Eagle Creek Basin is expected to increase from 86,700 in 1960 to 170,000 by the year 2020, with the major growth taking place in the vicinity of State College.

2. Municipal water use in North Bald Eagle Creek Basin is expected to increase from 12.4 mgd at present to 25 mgd by the year 2020.

3. Investigations indicate that current water supply sources, proposed facility expansions, and locally undeveloped ground and surface waters will be adequate to meet the estimated future municipal water requirements.

4. Economic projections indicate that employment will continue to increase in the pulp and paper industries, transportation equipment manufacturing, retail trade, and the service industry. The major industrial water user within the Basin, New York and Pennsylvania Company (pulp and paper) at Lock Haven, has indicated a possible doubling of its production capacity by the year 2020.

5. Industrial water use in North Bald Eagle Creek Basin is estimated to increase from 98 to 125 mgd by the year 2020.

6. Existing natural stream flows (minimum day with recurrence frequency of once in 20 years) are adequate to meet the anticipated future industrial water requirements within the Basin.

7. The municipal and industrial waste loads discharged to North Bald Eagle Creek below the proposed reservoir, following adequate treatment, are estimated to be 52 mgd, with a P.E. of 61,000 by the year 2020.

8. Existing natural stream flows (minimum annual average flow statistically distributed to determine probable mean monthly discharges recurring once in 20 years) are adequate to assimilate the municipal and industrial waste loads and maintain the dissolved oxygen objective of 5 mg/l.

9. Investigations indicate that there is no need for storage in the proposed reservoir for purposes of municipal and industrial water supply or for regulation of organic waste assimilation.

10. The mechanics of fish kills in the West Branch Susquehanna River are not fully understood; however, it appears probable that they may occur as the result of one or a combination of the following: high concentrations of acid, causing intolerable pH levels; high concentrations of iron as ferric hydroxide in suspension; or chemical oxidation, causing severe depletions of dissolved oxygen.

11. The composition of "slugs" cannot be defined because of an inadequate knowledge of the in-stream chemistry of waters containing mine drainage. However, formation is possibly the result of three sequential events:

a. Physical flushing of pools containing concentrated pollutants.

b. Chemical reactions going to completion with resultant high concentrations of acid and/or potential acid formers because of dilution within the stream.

c. Physical scouring of the stream bottom, re-suspending precipitated materials.

12. With respect to storage in the Blanchard Reservoir for quality improvement in the West Branch below the North Bald Eagle confluence, the inability to perform a stoichiometric alkalinity-acidity balance prevents an accurate determination at this time of the magnitude of the need for and benefits from storage in the proposed reservoir for quality control.

13. The proposed Corps of Engineers' operation schedule for Blanchard Reservoir may have an adverse effect on the quality of North Bald Eagle Creek below the Reservoir, as well as on a reach of an unpredictable length of the West Branch Susquehanna River, by extending acid conditions during periods of filling.

14. Concentrations of inorganic nitrates and phosphates in North Bald Eagle Creek at the proposed site, if not substantially reduced, may cause severe algal problems in the reservoir. The value of the reservoir for recreation and as a fishery may be greatly reduced.

15. Water quality in deep impoundments becomes degraded with depth because vertical stratification prevents mixing of surface and bottom waters. It is recommended that multi-level outlets be incorporated in the proposed structure to allow releases from several depths, thereby providing positive control of the discharges to meet downstream dissolved oxygen requirements.

III. DESCRIPTION OF PROJECT

LOCATION

The proposed Blanchard Reservoir will be located on North Bald Eagle Creek in Centre County, Pennsylvania. The site is approximately 15 miles upstream from the City of Lock Haven. See Figure 1, following page 77.

STREAM FLOW

The proposed reservoir would control run-off from 339 square miles of drainage in Centre County, Pennsylvania. The average annual discharge of North Bald Eagle Creek at the reservoir site is 465 cfs, with a minimum flow of 93 cfs, and a maximum flow of 5,900 cfs, based on 10 years of record.

WATER QUALITY

North Bald Eagle Creek, at the site of the proposed reservoir, is alkaline, with relatively high concentrations of inorganic nitrogen and phosphorus. The quality of the water, however, is satisfactory for most beneficial uses. A tabulation of water quality data is presented in Exhibit F.

PERTINENT DATA

Presented below are the elevations, surface areas, and storage volumes for the proposed Blanchard Reservoir.

	Elevation (feet)	Surface Area (acres)	Total Storage (acre feet)
Spillway Surcharge	677.7	4,950	186,000
Flood Control	657.0	3,450	99,000
Normal Summer Pool	630.0	1,730	28,800
Minimum Summer Pool	628.0	1,590	25,500
Winter Pool	610.0	630	6,300
Streambed	583.0	0	0

As presently proposed, from November 15 to March 15, the winter pool (elevation 610.0) will be maintained except for the storage volume which is available for flood control. From March

15 to May 15, water will be stored until an elevation of 632.0 feet is reached. The pool will then be lowered to an elevation of 630.0 feet at a time (usually by mid-June) designated by the Pennsylvania Fish Commission to aid in fish management. During the period of mid-June to Labor Day, two feet (elevation 630.0 to 628.0) will be available for water quality control. These two feet are equivalent to 3,300 acre feet of storage, or 0.18 inches of run-off. Following each release for water quality control, the pool will be raised to an elevation of 630.0 feet, if this can be done while maintaining satisfactory water quality downstream. During the period from Labor Day to mid-November, the pool will be lowered from an elevation of 630.0 feet to 610.0 feet, in preparation for holding flood flows. This 20 feet of storage, which amounts to 22,500 acre feet, will be available for water quality control during the draw down period.

IV. DESCRIPTION OF STUDY AREA

LOCATION AND BOUNDARIES

The North Bald Eagle Creek Basin has a drainage area of 782 square miles, of which 77 per cent and 23 per cent lie in Centre and Clinton Counties, respectively. (See Figure 1.) The headwaters are in the extreme southern part of Centre County. The stream flows for about 50 miles, primarily in a northeasterly direction, before discharging into the West Branch Susquehanna River near the City of Lock Haven.

The principal tributaries of the North Bald Eagle Creek are Spring, Beech, and Fishing Creeks, with drainage areas of 146, 172, and 183 square miles, respectively. The confluence of North Bald Eagle Creek and the West Branch Susquehanna River is 67.7 miles upstream from the confluence of the West Branch and the North Branch Susquehanna River.

GEOGRAPHY

The North Bald Eagle Creek Basin is divided into two distinct areas by Bald Eagle Mountain. Bald Eagle Valley, the northern area, is bounded by the Allegheny Front to the northwest and Bald Eagle Mountain to the southeast. Within this valley, which is 35 miles long and about 5 miles wide, the North Bald Eagle Creek stream bed drops from an elevation of over 1,100 feet at the headwaters to 583 feet at the proposed reservoir site. The bedrock of this valley is predominately limestone and sandstone. A small area in the northwestern section of the valley contains bituminous coal deposits. Most of Bald Eagle Valley is covered with forest.

The southern area, known as Nittany Valley, is bounded by Bald Eagle Mountain to the northwest and Nittany and Tussey Mountains to the south and east. Nittany Valley, underlaid mostly by limestone deposits, has rolling hills and is about 25 miles long and 10 miles wide. Within Nittany Valley the stream channel slopes are moderate, and many of the tributaries are intermittent streams, which are characteristic of limestone regions. Most of Nittany Valley is unforested, with the land classified as fair for agricultural purposes.

CLIMATE

The mean annual precipitation within the North Bald Eagle Creek Basin, based on over 45 years of record, is approximately 38 inches, which includes an average annual snowfall of approximately 42 inches. The mean annual temperature is 45°F. with a mean monthly low of 27°F. in January and a mean monthly high of 76°F in July.

PRINCIPAL COMMUNITIES AND INDUSTRIES

Principal communities within the North Bald Eagle Creek Basin are the boroughs of Bellefonte and State College. The City of Lock Haven is on the Basin divide, with most of the City being along the West Branch Susquehanna River.

Two major manufacturing plants, New York and Pennsylvania Company and Piper Aircraft Corporation, are located in Lock Haven. The major industry in Bellefonte is Cerro Copper and Brass Company. The West Penn Power Company, which has a generation capacity of 46,000 kilowatts, is located in Milesburg, on Spring Creek.

V. THE ECONOMY

INTRODUCTION

Water quantity and water quality requirements of an area affected by a reservoir are determined, in part, using projections of the area's population and economic growth. Growth of an area depends not only on its own particular characteristics, but also upon the type and extent of growth experienced by the Nation and the region of which it is a part.

The area of influence of the proposed Blanchard Reservoir is composed of Centre, Clinton, Lycoming, Union, and Sullivan Counties, Pennsylvania. This area has been designated the Williamsport Economic Sub-region by the National Planning Association of Washington, D. C., in the preparation of an economic base study for the Susquehanna River Basin financed jointly by the Public Health Service and the Corps of Engineers.

The demographic and economic data presented in this report have been developed within the context of preliminary information prepared by the National Planning Association. It should be noted that the projections may require modification upon completion of the economic base study.

PRESENT ECONOMY

In 1960, about three-quarters of the population of the Williamsport Economic Sub-region was located in Lycoming and Centre Counties, 42.5 and 30 per cent, respectively. Of the remaining population, 15 per cent resided in Clinton County, 10.1 per cent in Union County, and 2.4 per cent in sparsely inhabited Sullivan County.

The total population in the Sub-region increased by approximately 10 per cent from 1950 to 1960, as shown in Table 1. There has been a continuing trend toward urbanization with most of the population increase appearing in the rural non-farm class and a small increase in the urban areas. All age groups showed some increases during the decade, but a negligible rise in the 21 to 65 age group indicates some probable out-migration of individuals.

All, or parts, of the five counties in the Sub-region have experienced more severe unemployment than the National average, and each have been classified as "redevelopment areas"

Table 1

POPULATION BY AGE GROUPS AND BY TYPE OF RESIDENCE
WILLIAMSPORT ECONOMIC SUB-REGION
(CENTRE, CLINTON, LYCOMING, UNION, AND SULLIVAN COUNTIES)

		AGE							
	Total	Under 5		5 - 21		21 - 65		Over 65	
Year	(Thousands)	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
1950	233.5	19.3	8.3	63.0	27.0	130.0	55.7	21.2	9.1
1960	257.3	27.0	10.5	75.0	29.2	130.4	50.7	24.9	9.7
Percentage change	10.2	39.9		19.0		0.3		17.5	

		TYPE OF RESIDENCE					
	Total	Urban		Rural Non-farm		Rural Farm	
Year	(Thousands)	No.	Per Cent	No.	Per Cent	No.	Per Cent
1950	233.5	113.7	48.7	90.7	38.8	29.1	12.5
1960	257.3	119.	46.3	121.7	47.3	16.4	6.4
Percentage change	10.2	4.8		34.2		-43.6	

by the Area Redevelopment Administration. In Centre County, this classification applies to the western portion, which includes the Clearfield-Dubois labor market area. It also applies to the southeastern portion of Union County for the Sunbury-Shamokin-Mt. Carmel labor market area.

Total employment in the Sub-region increased from approximately 84,000 in 1950 to 88,000 in 1960, as shown in Table 2. There was, however, a commodity employment decrease of about 5,000. Significant employment decreases also occurred in agriculture, mining, and the manufacturing industries of textiles, leather, stone, clay, glass, primary metals, and fabricated metals. Reduced employment in some of these industries came primarily from advances in technology (i.e., agriculture, mining, and primary metals). Other reductions came from changes in locational advantage relating to raw materials (i.e., stone, clay, and glass). Textile employment suffered from the trend of transferring this industry to the South.

The only industry which experienced a large increase in employment during the 1950-1960 decade was the transportation equipment industry. This increase was primarily in the aircraft industry. In addition, small increases in employment occurred in paper, food, apparel, and non-electrical machinery.

Employment in all the non-commodity industries in the Sub-region increased in parallel with the National trends.

The majority of the agricultural employment is found in Lycoming and Centre Counties and is involved primarily in dairy farming. Some acreage is devoted to vegetables in Union and Centre Counties. Pulpwood and saw timber are produced throughout the Sub-region.

Bituminous coal is mined in Centre and Clinton Counties. Mining employment, however, declined from 2,200 to 600 between 1950 and 1960.

More than one-half of the manufacturing activity in the Sub-region is centered around Williamsport in Lycoming County and is well diversified. Approximately 20 per cent of the activity is located in Clinton County, with slightly less than one-half found in an aircraft plant in Lock Haven. Another 15 per cent is in Centre County, with one-quarter of the employment found in a copper drawing and extruding plant.

Pennsylvania State University is located in State College Borough in Centre County. Educational and research activities

Table 2

EMPLOYMENT BY INDUSTRY
WILLIAMSPORT ECONOMIC SUB-REGION 1950 AND 1960

Industry	1950	1960
Agriculture, Forestry, Fisheries	6,800	4,640
Mining	1,780	1,190
Construction	1,980	1,840
Food and Kindred Products	1,500	1,670
Tobacco	270	420
Textile Mill Products	3,220	2,350
Apparel and Other Products	3,590	3,740
Lumber	1,390	1,040
Furniture	2,160	2,100
Paper and Allied Products	1,640	1,920
Printing and Publishing	1,100	1,090
Chemicals and Allied Products	600	510
Petroleum Refining	---	60
Rubber	40	180
Leather	1,400	820
Stone, Clay, and Glass	1,800	810
Primary Metals	3,370	2,420
Fabricated Metals	2,170	1,600
Non-electric Machinery	690	1,110
Electrical Machinery	3,700	2,820
Transportation Equipment	2,220	3,790
Instruments	30	230
Miscellaneous	230	330
Transportation, Communication, Utilities	2,450	2,760
Trade	10,230	10,920
Finance	1,170	1,670
Services	20,490	24,160
Government	8,220	12,220
Total	84,220	88,410

Source: National Planning Association preliminary unpublished data

carried out by the University represent a major source of employment generated by demands outside the Sub-region.

FUTURE ECONOMY

Table 3 shows projected employment by industry categories to 1990. The rate of growth is expected to be gradual, but at a slightly faster rate than between 1950 and 1960. The non-commodity industries are projected to provide the major increase, with commodity industry growth in transportation equipment, paper and allied products, non-electrical machinery, food, and apparel. Projected increases in employment in these industries are based on the comparative advantage which this Sub-region apparently had for these industries in the past.

Production of wood pulp in the Williamsport Economic Sub-region has been projected by the Northeast Forest Experiment Station, U. S. Forest Service, U. S. Department of Agriculture for the Susquehanna River Basin Studies of the Public Health Service and the Corps of Engineers as follows:

Year	Projected Production of Wood Pulp Williamsport Sub-region
1962	25,000 tons
1970	50,000 tons
1980	150,000 tons
1990	200,000 tons
2000	300,000 tons
2020	300,000 tons

The Forest Service assumes that production will increase in present mills and through establishment of new mills. It further assumes that the minimum capacity for new pulp mills will be 100,000 tons per year. At the present time, all pulp produced in the Sub-region is produced at Lock Haven. No location of new plant sites within the Sub-region has been indicated.

Projected employment in the service type industries is in accordance with the National trends, and reflects the influence favorable recreational resources of the Sub-region may have on the development of the area.

Population projections to 1980, as shown in Table 4, are based on the projected employment, with the 2020 population based on an extension of the trend line. (Figure 2) County and municipal area projections are based on their past relationship to the larger areas.

Table 3

PROJECTED EMPLOYMENT BY INDUSTRY
WILLIAMSPORT ECONOMIC SUB-REGION 1970-1990

Industry	1970	1980	1990
Agriculture, Forestry, Fisheries	3,990	4,460	4,460
Mining	820	720	690
Construction	2,290	2,950	3.800
Food and Kindred Products	2,210	2,690	3,000
Tobacco	410	370	550
Textile Mill Products	2,140	1,790	1,550
Apparel and Other Products	3,830	4,090	4,300
Lumber	1,100	1,000	900
Furniture	2,270	2,420	2,600
Paper and Allied Products	2,300	2,400	2,600
Printing and Publishing	930	780	730
Chemicals and Allied Products	320	120	120
Petroleum Refining	90	120	150
Rubber	340	540	750
Leather	760	710	700
Stone, Clay, Glass	730	630	600
Primary Metals	1,740	1,200	1,100
Fabricated Metals	1,030	490	500
Non-electric Machinery	2,390	2,950	3,500
Electrical Machinery	1,890	410	500
Transportation Equipment	5,260	6,890	8,000
Instruments	470	740	1,000
Miscellaneous	450	580	700
Transportation, Communication, Utilities	3,320	3,180	3,000
Trade	13,670	14,850	16,000
Finance	2,500	3,080	3,600
Services	29,080	39,050	50,000
Government	21,650	27,700	30,000
Total	107,990	126,920	145,200

Source: National Planning Association preliminary unpublished data

Table 4

HISTORICAL AND PROJECTED POPULATION
FOR SELECTED AREAS
NORTH BALD EAGLE CREEK BASIN

Area	1940	1950	1960	1970	1980	2020
Williamsport Economic Sub-region	188,302	233,598	257,463	277,000	332,000	450,000
Centre County	52,608	65,922	78,580	89,449	101,702	160,000
Clinton County	34,557	36,632	37,619	38,648	39,074	41,000
Total	87,165	102,454	116,199	128,097	140,776	201,000
Bald Eagle Creek Basin*	57,384	74,384	86,764	97,000	110,000	170,000
State College Area (Centre County) (Includes State College Borough, and College and Ferguson Townships)	9,618	21,890	30,198	40,000	53,000	128,000
Bellefonte Area (Centre County) (Includes Bellefonte Borough and Spring Township)	9,357	10,251	11,106	11,800	12,400	15,500
Lock Haven Area (Clinton County) (Includes Lock Haven City, Flemington and Mill Hall Boroughs, and Allison, Castanea, and Woodward Townships)	16,449	18,180	18,611	19,000	19,500	21,000

* Basin area boundary approximated by township boundaries.

VI. INVESTIGATIONS

WATER USES AND SOURCES OF SUPPLY

Municipal

There are 29 water utilities, privately or municipally owned, which supply the municipal water needs of the North Bald Eagle Creek Basin and the Lock Haven area. (See Exhibit A) Summarized below are source of water, population served, and average daily use of these 29 public water supplies.

Source of Water	Population Served	Average Use (MGD)
Ground Water	60,000	7.5
Surface Water	21,000	4.9
Total	81,000	12.4

Of the 29 public water supplies, six provide over 97 per cent of the daily municipal water needs of the Basin. These six are Lamont Water Company, Lock Haven City Authority, Suburban Lock Haven Water Authority, Bellefonte Borough Authority, State College Borough Authority, and Pennsylvania State University. The current distribution of water use based on metered records for the six water supplies are as follows: 40 per cent for residential use, 10 per cent for commercial use, 26 per cent for industrial use, and 24 per cent for public and other use. (The majority of the public and other use is by Pennsylvania State University.)

Excluding Pennsylvania State University, the five other public water supplies had a metered use of 147 gallons per capita per day (gpcd) in 1950. In 1962 the metered use for these five supplies increased to 154 gpcd.

The principal municipal water user of the West Branch Susquehanna River, below its confluence with North Bald Eagle Creek, is the White Deer Water Company at Milton, Pennsylvania. Milton is located approximately 57 river miles downstream from the confluence.

Industrial

The major use of water within the Basin is for industrial purposes. Tabulated in Exhibit A are the industrial water uses

within the Basin and the Lock Haven area. A summary of the water sources and average daily use of the major industrial water users is shown below.

Source of Water	Average Daily Use (MGD)
Surface water	96.4
Ground water	1.6
Municipalities	2.8
Total	100.8

The daily water requirements of West Penn Power Company and New York and Pennsylvania Company comprise about 96 per cent of the total industrial water needs within the Basin. West Penn Power Company, the major user upstream from the proposed reservoir, has an average water intake of about 43 mgd from Spring Creek. A majority of this water is used for cooling purposes. The New York and Pennsylvania Company, the only current user of water below the proposed reservoir, has an average water intake of 53 mgd. Of the 53 mgd of water intake, 30 mgd (or 57 per cent) is used for cooling purposes, and the remaining 23 mgd (or 43 per cent) is used for process water.

Tabulated below is a breakdown of water usage by the major water using industries.

Use by Industry	Average Daily Use (MGD)	Per Cent of Total
Potable water	0.8	0.8
Process water	25.8	25.5
Cooling water	74.2	73.7
Total	100.8	100.0

Currently there are no industries using the West Branch Susquehanna River as a source of water supply below its confluence with North Bald Eagle Creek.

Other

Spring Creek and North Bald Eagle Creek (downstream as far as the proposed reservoir site) are stocked with brown, brook, and rainbow trout. Smallmouth bass and pickerel are also found in these waters. Sections of Spring Creek have been designated by sportsmen as a "fishermen's paradise."

Water from Spring Creek has been used for irrigation purposes with the Rockview Penitentiary being the major user. The other major agricultural use of water is for watering livestock.

SOURCE OF WASTE

Principal sources of municipal and industrial waste in North Bald Eagle Creek Basin are given in Exhibit B. Volumes and strength in population equivalents (P.E.) of the treated waste water being discharged to the surface waters are summarized below by sub-basins.

Sub-basin	Municipal Flow (MGD)	Municipal P. E.	Industrial Flow (MGD)	Industrial P. E.
Beech Creek	0.0	0	0.0	0
Spring Creek	4.5	5,300	45.1	0
Fishing Creek	0.0	0	0.0	0
Main Stem North Bald Eagle Creek	1.3	7,600	55.1	121,000
Total	5.8	12,900	100.2	121,000

Within Spring Creek Basin, Bellefonte Borough, Pennsylvania State University (including State College Borough), and Rockview Penitentiary are the three largest sources of municipal waste. The three are currently providing secondary treatment with a biochemical oxygen demand (BOD) removal of 85 per cent or more. The major industrial waste discharge in the sub-basin is from West Penn Power Company, which reports a cooling water discharge of approximately 43 mgd.

There are three large waste water discharges to the main stem of North Bald Eagle Creek in the Lock Haven area. The New York and Pennsylvania Company, which is providing primary treatment, reports discharges of about 53 mgd of process waste and cooling waters with a P. E. of over 118,000. The City of Lock Haven, currently providing primary treatment, has a waste water flow of 1.3 mgd, with a P. E. of over 7,000. Koppers Incorporated, which is providing secondary treatment, has a waste water discharge of 2.0 mgd at a P. E. of about 3,000.

FUTURE WATER SUPPLY REQUIREMENTS

Municipal

Municipal water demands will vary with the economy, size, topography, availability of water, and other factors. The Senate Select Committee Print No. 7 states that in 1954 the average national use was 147 gpcd[7]. The projected use for the State of Pennsylvania for the year 1980 and the year 2020 is 154 gpcd.

Current average water use within the North Bald Eagle Creek Basin is 154 gpcd. The annual per capita increase in metered water use for the five major water utilities in the Basin from 1950 to 1962 was 0.39 per cent. From Committee Print No. 7, the annual per capita rate of increase of water use for the State of Pennsylvania is expected to be 0.18 per cent until the year 1980. After that time, per capita use is expected to remain constant.

To facilitate the evaluation of future municipal water needs, three major water use areas were established. These are the Lock Haven, Bellefonte, and State College areas. Other communities in the area are small and insignificant or are too distant to utilize water from the proposed reservoir. The projected water requirements for the areas are tabulated below.

Water Use Area	1960 Population	Current Water Use gpcd	Projected 2020 Population	Projected* 2020 Water Use (gpcd)	Projected 2020 Water Needs (MGD)
Lock Haven	20,000	184	22,000	189	4
Bellefonte	11,000	310+	15,500	318+	5
State College	30,200	120	128,000	124	16

* Projection based on 0.18 per cent annual increase up to the year 1980.

\+ High individual water usage for Bellefonte is caused, in part, by industrial use and the ample supply available.

The projected municipal water needs, as summarized above, show that State College area is expected to increase its total water requirements 220 per cent by the year 2020, to an annual usage of about 16 mgd. Pennsylvania State University obtains the majority of its water from three wells ranging from 340 to 600 feet deep and rated at 70 to 310 gallons per minute (gpm). State College Borough also obtains the majority of its water

from three wells ranging from 155 to 165 feet deep, with yields varying from 800 to 1,650 gpd.

Cambrian and Ordovician limestone and dolomite, which underlie the State College area as reported by the Pennsylvania Topographic and Geological Survey[20], contain substantial ground water resources. These limestone and dolomite formations are the most productive water bearing rocks in the area east of this Allegheny Front. Numerous wells in this area are reported to yield from 200 to more than 500 gpd. Many springs with substantial dry-weather flow are also found in this area; one being the Bellefonte Spring, which has a yield of over 11 mgd.

The future water needs of State College area will probably be obtained from ground sources. If ground water becomes inadequate, there are numerous local, small watersheds which could be developed. It is not likely that the State College area will turn to the proposed reservoir to satisfy future water demands, as the reservoir is approximately 30 miles downstream, with an elevation differential of over 600 feet.

The Bellefonte area's water requirements are projected to be 5 mgd by the year 2020. The Borough of Bellefonte is currently obtaining its water from a spring which has a yield of over 11 mgd. This should be more than sufficient to meet the future water needs.

The Lock Haven area, supplied by the Suburban Lock Haven Water Authority and the Lock Haven City Authority, experienced water shortages in 1962 and 1963. At the present time, the Lock Haven City Authority is increasing its impoundment capabilities in a watershed outside of the North Bald Eagle Creek Basin. The Suburban Lock Haven Water Authority also obtains its water from sources outside the Basin and is presently considering the recommendations of a consulting firm to expand their sources. The current expansion by the Lock Haven City Authority, and the proposed expansion by the Suburban Lock Haven Water Authority, will increase the combined capabilities from 3.5 to 7.4 mgd. This increase will be more than sufficient to meet projected water needs of the area.

Industrial

Industries can be categorized into two general classes--dry and wet. Dry type industries are those which use little or no water in their manufacturing processes. Wet industries require varying quantities of water, depending on the process or

product. The amount of water required per unit of production may vary from plant to plant, depending on location, availability of water, and other factors. The prime uses of water in industry are for cooling and processing.

Since 1900, industrial water use in the United States has increased more than sixfold. Future industrial water requirement projections vary tremendously. The paper industry, the largest water using industry within the Williamsport Sub-region, is expected to double its production by the year 2020. This increase in production will probably double the industry's water requirements by 2020.

New York and Pennsylvania Company, the largest water user within the Basin, has indicated its water requirements will increase by 10 per cent in the next five to ten years. The company has also indicated that due to an almost unlimited supply of pulp in the area, water requirements may double by the year 2020. West Penn Power Company, the other major water user within the Basin, has indicated that there are no plans to expand the Milesburg Power Station. The station is currently operating at maximum capacity.

The industrial water needs in the North Bald Eagle Creek Basin, based on the economic projection, are anticipated to increase from 98 mgd in 1963 to about 125 mgd in 2020. New York and Pennsylvania Company, the only industrial user from North Bald Eagle Creek below the proposed reservoir, anticipates an increase in process water use from 23 mgd in 1963 to 46 mgd in 2020. Additional cooling water requirements will probably be obtained by recirculation and other water conservation methods as commonly practiced by the paper industry in Pennsylvania.

The minimum daily flow, with a frequency of occurrence of once-in-20-years in North Bald Eagle Creek below its confluence of Fishing Creek, is 140 cfs. The process water requirements of New York and Pennsylvania Company will be about 70 cfs in the year 2020. The current stream flow is expected to adequately supply the projected needs of the paper company during the study period. Anticipated future water needs in the Lock Haven area are provided for in the current expansion programs of the two water authorities serving the area.

PRESENT WATER QUALITY

Available data indicates that the West Branch Susquehanna River, above its confluence with North Bald Eagle Creek,

is generally acidic in character. Further, it appears that North Bald Eagle Creek, Pine Creek, and other downstream tributaries neutralize and dilute reaction products resulting from the interaction with the mine drainage pollutants present in the West Branch.

Within the North Bald Eagle Creek Basin, stream quality data has shown that Beech Creek contains mine drainage; Spring Creek is highly alkaline, with fairly high concentrations of inorganic nitrogen and phosphorus; Marsh Creek is moderately alkaline; and Fishing Creek, plus municipal and industrial waste discharges near Lock Haven, also contributes to the alkaline content of North Bald Eagle Creek.

Flow data for stream gaging stations in the area of consideration were obtained from the U. S. Geological Survey. For descriptions of these stations, see Table 14 in Exhibit C. The method used to obtain representative flow at points for which flow records were not available is also explained in Exhibit C. Mean monthly flows for all sampling stations are tabulated in Tables 13 and 14, Exhibit C.

Chemical quality data were obtained from the Pennsylvania Department of Health, the U. S. Geological Survey, and the New York and Pennsylvania Company. In Exhibit D is a description of sampling, methods of analysis, and reporting by the three agencies. Also within Exhibit D is the method used to interpret the quality data. The sampling stations and the water quality data are tabulated in Exhibit F.

North Bald Eagle Creek

Stream survey data by the U. S. Geological Survey and the Pennsylvania Department of Health has shown there are concentrations of nitrates and phosphates ranging from 1.0 to 7.4 mg/l and 0.29 to 4.60 mg/l, respectively at the proposed reservoir site. The major source of the nitrates and phosphates is the sewage treatment plant effluent from Pennsylvania State University. The effluent, discharged into a tributary of Spring Creek, contains about 477 pounds of inorganic nitrogen and 90 pounds of inorganic phosphorus per day, at a flow of 3.3 cfs, as determined in 1960[27]. These inorganic nitrogen and phosphorus nutrients have caused extensive algal growths in sections of Spring Creek.

Surveys conducted in Spring Creek Basin by the Pennsylvania Department of Health and others indicate there is a great

fluctuation of dissolved oxygen (D. O.) in the stream[12]. It appears that fluctuation in D. O. in Spring Creek is related to an overabundance of aquatic life which produces an excess of D. O. by photosynthesis during daylight hours, accompanied by rapid, around-the-clock respiratory use, resulting in D. O. deficiencies during hours of darkness.

To alleviate the nutrient problem in Spring Creek, Pennsylvania State University has undertaken a research study to determine the feasibility of land application of sewage effluent. If research indicates that land application is feasible, the sewage effluent will be disposed of by this method, thus relieving the nutrient problem in Spring Creek.

A limited field survey was made by the Public Health Service, in cooperation with the Pennsylvania Department of Health, downstream from Cerro Copper and Brass Company, to determine concentrations of heavy metals. Results of the survey indicate that heavy metal concentrations in the receiving waters at the site of the proposed reservoir are well within acceptable limits for the propagation of fish and other aquatic life, as well as other beneficial water uses.

North Bald Eagle Creek is the main source of alkalinity for the West Branch Susquehanna River. The mean concentration and pounds of alkalinity or acidity, expressed as $CaCO_3$ by months, at the sampling stations in North Bald Eagle Creek Basin, are presented in Table 5. The summarized data below indicates that approximately two-thirds of total available alkalinity in the Basin is present above the proposed reservoir site.

North Bald Eagle Creek	Average Concentration Alkalinity as $CaCO_3$ mg/l	Pounds Per Day Alkalinity as $CaCO_3$
At Blanchard	102	218,000
At Mill Hall	65	233,000
At Confluence With West Branch Susquehanna River	69	332,000

There is approximately a 36 per cent reduction in the unit concentration of alkalinity between Blanchard and Mill Hall, primarily due to the interaction of the acidic waters of Beech Creek. Based on an average annual discharge of 280 cfs, Beech Creek yields about 35,000 pounds of acid per day. The acid

Table 5

MEAN CONCENTRATION AND POUNDS OF ALKALINITY OR ACIDITY
BY MONTHS AT VARIOUS STATIONS
NORTH BALD EAGLE CREEK BASIN

	North Bald Eagle at Blanchard[1] Alk. as $CaCO_3$		Beech Creek at Confluence[1] Acid as $CaCO_3$		North Bald Eagle at Mill Hall[2] Alk. as $CaCO_3$		North Bald Eagle at Confluence[2] Alk. as $CaCO_3$	
	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
Oct.	118	158,500	34	21,900	76	158,500	84	227,000
Nov.	103	199,000	27	25,200	64	208,000	71	322,000
Dec.	100	209,000	26	35,300	62	225,000	64	317,000
Jan.	92	234,000	24	41,700	56	257,000	59	381,000
Feb.	89	253,000	23	43,000	54	271,000	54	393,000
March	74	346,000	18	64,000	43	388,000	42	542,000
April	75	331,000	18	60,700	44	375,000	43	496,000
May	82	286,000	22	48,500	49	317,000	48	443,000
June	103	197,000	27	32,500	64	207,000	66	298,000
July	120	157,000	35	20,700	78	154,000	87,	220,000
Aug.	128	134,000	40	16,600	86	132,000	98	189,000
Sept.	140	121,000	48	12,200	96	108,000	115	158,000
Average	102	218,000	29	35,000	65	233,000	69	332,000

1 U. S. Geological Survey data

2 New York and Pennsylvania Company data

contribution of Beech Creek becomes more significant during rainstorms in the spring, summer, and fall months. During these rainstorms, the flow from Beech Creek, which has a "flashy" drainage characteristic, often exceeds that of North Bald Eagle at Blanchard. The effect of the acid from Beech Creek is somewhat reduced by alkaline waters of March Creek. Based on an average annual discharge of 51 cfs, Marsh Creek contributes from about 500 to 10,000 pounds of alkalinity per day. Even though the concentration of alkalinity is reduced in North Bald Eagle between Blanchard and Mill Hall, the total pounds per day of alkalinity is increased slightly.

West Branch of the Susquehanna River

The West Branch of the Susquehanna River at Lock Haven is acidic in character, as previously noted. The U. S. Geological Survey sampling information at Lock Haven, modified to indicate acidity in terms of calcium carbonate, is presented below.

Water Year	Mean Discharge cfs	Avg. Acidity as $CaCO_3$ mg/l	Tons of Acid as $CaCO_3$ per year	Average Tons Per Day
1946	5351	22	80,400	220
1948	4832	41	143,600	393
1950	8643	28	161,500	443
1959	5010	24	65,700	180

As shown in Table 6, the waters of North Bald Eagle Creek alkalify the West Branch Susquehanna River. In reviewing the pounds of alkalinity or acidity by months, it is evident that there is always more acidity in the West Branch at Lock Haven than there is alkalinity in North Bald Eagle Creek. However, the data for the two stations downstream from North Bald Eagle indicate that the West Branch is an alkaline stream. It should be noted that there is a significant difference in acidity determinations as made by the U. S. Geological Survey at Lock Haven and those made by the Pennsylvania Department of Health at Renovo. The acidity-alkalinity balance problem and the difference in present analytical methods are further explained in Exhibit D.

Table 6 indicates that alkalinity in the West Branch between the confluence of North Bald Eagle Creek and Williamsport is further increased by Pine Creek and Lycoming Creek.

Table 6

MEAN CONCENTRATION AND POUNDS OF ALKALINITY OR ACIDITY
BY MONTHS AT VARIOUS STATIONS
WEST BRANCH SUSQUEHANNA RIVER AND NORTH BALD EAGLE CREEK

	West Branch at Renovo[1] Acid as $CaCO_3$		West Branch at Lock Haven[2] Acid as $CaCO_3$		North Bald Eagle at Confluence[3] Alk. as $CaCO_3$		West Branch Below North Bald Eagle[3] Alk. as $CaCO_3$		West Branch at Williamsport[1] Alk. as $CaCO_3$	
	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
Oct.	28	305,000	23	266,000	84	227,000	11	157,000	12	253,000
Nov.	18	346,000	18	366,000	71	322,000	9	220,000	10	330,000
Dec.	15	362,000	17	420,000	64	317,000	8	240,000	9	384,000
Jan.	12	425,000	15	522,000	59	381,000	7	295,000	8	447,000
Feb.	12	392,000	15	492,000	54	393,000	7	280,000	8	447,000
March	7	456,000	11	722,000	42	542,000	5	415,000	6	697,000
April	8	445,000	12	700,000	43	496,000	6	405,000	7	667,000
May	10	415,000	14	555,000	48	443,000	7	313,000	8	529,000
June	17	331,000	11	372,000	66	289,000	9	225,000	10	385,000
July	40	277,000	29	217,000	87	220,000	12	121,000	13	260,000
Aug.	41	257,000	28	204,000	98	189,000	13	120,000	14	204,000
Sept.	41	267,000	28	197,000	115	158,000	14	117,000	15	188,000
Average	21	356,000	19	419,000	69	332,000	9	242,000	10	399,000

1 Pennsylvania Department of Health data
2 U. S. Geological Survey data
3 New York and Pennsylvania Company data

These two creeks contribute between 70,000 and 300,000 pounds of alkalinity per day.

The neutralizing effect of North Bald Eagle, Pine, and Lycoming Creeks can be further established by comparing the pH at the various stations along the West Branch. The minimum and maximum pH values are tabulated below.

Station	Min.	Max.	Reporting Agency
West Branch at Renovo	3.2	5.8	Pennsylvania Department of Health
West Branch at Lock Haven	3.6	4.8	New York and Pennsylvania Company*
West Branch at Lock Haven	3.3	4.5	U. S. Geological Survey
North Bald Eagle at Confluence	7.1	8.0	New York and Pennsylvania Company*
West Branch Downstream from Confluence of North Bald Eagle	5.0	8.2	New York and Pennsylvania Company*
West Branch at Williamsport	5.0	8.2	New York and Pennsylvania Company*
West Branch at Williamsport	4.4	7.7	Pennsylvania Department of Health

* Results of summer survey.

Associated with the acidity in the West Branch at Lock Haven are the fairly high concentrations of iron, manganese, and sulfates. The ranges of concentrations of iron, manganese, and sulfates, as reported by the U. S. Geological Survey at Lock Haven during the water year of 1959, are 0 to 0.3 mg/l, 0.41 to 3.00 mg/l, and 38 to 250 mg/l, respectively. The Pennsylvania Department of Health has reported iron concentrations varying from 0 to 6.1 mg/l at Williamsport.

The West Branch, generally alkaline below the confluence with North Bald Eagle Creek, becomes highly acidic when subjected

to what is termed "acid flushout." A flushout, consisting of unneutralized acid and/or potential acid forming constituents, moving as a relatively coherent mass, is called an "acid slug." Occurrence of "slug" conditions was first discovered during investigations of fish kills in that reach of the West Branch below Lock Haven. During passage of a "slug," the alkaline waters of North Bald Eagle are incapable of neutralizing the acid load and, as a result, acidic conditions prevail as far downstream as Northumberland.

Since 1950, 16 fish kills in the West Branch have been attributed to "slugs." The mechanics of these fish kills are not fully understood. However, it appears probable that a kill may occur as the result of one or a combination of the following: high concentrations of acid causing intolerable pH levels, high concentrations of iron as ferric hydroxide in suspension, or chemical oxidation causing dissolved oxygen deficits.

Table 7 indicates that the 16 fish kills occurred during the months of June through October. It was found, upon review of the streamflow records that, in general, the following hydraulic conditions existed in conjunction with each kill:

1. Stream flows in North Bald Eagle, and the West Branch in particular, were below seasonal normals prior to each kill.

2. Stream flows in the West Branch at Renovo usually increased prior to an increase in North Bald Eagle Creek at Beech Creek Station.

3. The peak ratio attained between the flow of the West Branch and that of North Bald Eagle Creek was 5 to 1, or greater.

Streamflow records indicate that the above conditions also occur during the months of November through May, with no reported fish kills. It is possible that one or more of the following events negated "slug" formation during these months:

1. Flushing occurred prior to this period, thereby removing most of the "slug" constituents.

2. Sufficient flow existed both before and during this period to continually remove the "slug" constituents, allowing little or no opportunity for concentration.

Table 7

FISH KILL DATA
WEST BRANCH SUSQUEHANNA RIVER

Date of Reported Kill	Min. Flow Ratio* Before Kill	Max. Flow Ratio* Reached	No. of Days Ratio Greater Than 6:1
Sept. 9-13, 1963	2:1	10:1	9
Oct. 2, 1962	1:1	11:1	4
Aug. 6, 1961	3:1	13:1	5
July 20, 1961	4:1	14:1	10
June 16, 1960	3:1	28:1	7
Oct. 11, 1959	1:1	6:1	2
Aug. 26, 1959	2:1	6:1	1
June 28, 1958	4:1	14:1	5
July 18, 1958	4:1	16:1	6
Sept. 28, 1957	2:1	5:1	-
June 12, 1955	1:1	5:1	-
Oct. 12-17, 1954	2:1	14:1	14
Aug. 10-17, 1953	2:1	13:1	5
Aug. 20, 1952	1:1	9:1	2
July 28, 1951	3:1	14:1	2
July 8, 1950	3:1	8:1	2

* Flow ratio is daily mean discharge of West Branch at Lock Haven compared to daily mean discharge of the North Bald Eagle Creek at the confluence.

3. During preceding drought periods, recharge of potential "slug" forming areas was inhibited by absorption of precipitation in ground cover.

4. During the winter periods, snow and frozen terrain reduce or eliminate recharge of potential pools.

5. Heavy run-off in the upper reaches of the West Branch, while not causing a "slug" may affect the flow such that contents of the river itself will travel as a mass.

Based upon the available information, it appears that there is no direct relationship between the flows of the West Branch and those of North Bald Eagle to suggest that maintaining a particular flow ratio would eliminate the problem. The information does indicate, however, that rapid increases in West Branch flows, caused by rainfall or even untimely reservoir releases, apparently provide both the physical and chemical impetus necessary for the creation of a "slug."

Because of inadequate knowledge relating to the in-stream chemistry of waters subjected to mine drainage, the kinetics of the chemical reactions which result in the products found in "slugs" cannot be described. However, formation is probably the result of three sequential events.

1. Physical flushing of pools containing concentrated pollutants into the streams.

2. Chemical reactions going to completion with resultant high concentration of acid and/or potential acid formers because of dilution in the stream. (For example, it is known that the oxidation of ferrous iron to ferric is inhibited by high acid concentrations, pH below approximately 3.5. However, dilution by raising the pH and reducing the unit acid concentration will cause the reaction to proceed.)

3. Physical scouring of stream bottom causing high concentrations of suspended materials previously precipitated to move with the "slug." [The precipitates, composed of what is called "yellow boy," is principally hydrated ferric oxide (ferric hydroxide) and/or ferric sulfate. The latter may be the result of an incomplete chemical reaction believed to produce sulfuric acid.]

WATER QUALITY CRITERIA

Population growth combined with increased per capita use of water, expanding industrial requirements, and the mounting emphasis placed on recreational use of surface waters, all contribute to the importance of maximum protection and utilization of water resources. Water quality goals are the foundation upon which water programs are planned, with the objective of providing adequate quantities of water of suitable quality for all uses.

The Pennsylvania Department of Health has recommended the following objectives for the North Bald Eagle Creek, downstream from its confluence with Beech Creek:

1. Suitable for domestic and industrial water supply, propagation of game fish and recreational use.

2. Conducive to maintenance of the stream's present high alkalinity and excellent game fish habitat.

The Pennsylvania Department of Health has also recommended the following water quality objectives for the West Branch of the Susquehanna River downstream from its confluence with North Bald Eagle Creek:

1. Suitable for domestic and industrial water supply, propagation of game fish and recreational use.

2. Conducive to the reduction of acid and iron concentration and the elimination of periodic acid conditions.

The corresponding criteria for the above objectives are presented in Exhibit E.

Reduction or elimination of mine drainage pollution would improve the water quality of the West Branch and North Bald Eagle Creek, making them more suitable as sources of water supply and more desirable as habitat for aquatic life. The threshold concentrations for the major mine drainage pollutants (iron, acid, and manganese) vary depending upon water use. Since present water uses are expected to continue, established quality goals must be satisfactory for the propagation of warm-water aquatic life, industrial cooling, and pulp and paper manufacture.

The maximum concentrations of iron and manganese in industrial cooling water has been recommended as 0.5 mg/l[22]. Water used in the pulp and paper industry has a maximum permissible combined iron and manganese concentration range of 0.1 to

1.0 mg/l[22]. The actual value is a function of the manufacturing process and product quality.

Ellis[4] reported that 95 per cent of the waters in the United States supporting good fish life have an iron concentration of 0.7 mg/l, or less. It has also been reported that, in some cases, iron, probably in a semi-colloidal state, may be harmful to fish at concentrations as low as 0.1 to 1.0 mg/l[21]. Iron, however, at these low concentrations has not been found toxic at tolerable pH levels in the chemical form of common ferric and ferrous salts.

According to a literature survey[4], manganese concentrations of less than 1.0 mg/l will not be deleterious to fish and aquatic life.

Huet[15] reported the best waters for supporting and rearing fish are those with pH values between 7 and 8 and having a reserve alkalinity of 100 mg/l. The reserve acts as a buffer to prevent sudden changes in pH. Tarzwell[19] indicated that pH ranges of 6.5 to 8.5 are desirable for fish propagation. Most industrial uses require water having pH values of 6.5 to 8.8.

The minimum level of dissolved oxygen, as reported by Tarzwell[14], in waters suitable for a well-rounded, warm-water fish population, should not be below 5 mg/l.

Based upon the present and expected water uses within the area of influence of the proposed reservoir, the following water quality goals have been established for purposes of this report:

Iron	0.5 mg/l (maximum)
Manganese	0.5 mg/l (maximum)
pH	6.5 - 8.5
Dissolved oxygen	5 mg/l (minimum)

The State of Pennsylvania has an active program directed toward the reduction and eventual elimination of mine drainage. Through this program, mine pollution has already been substantially reduced in several limited areas. In the future, as the pollutional load is reduced, the iron, manganese, and pH goals can be achieved.

QUALITY CONTROL REQUIREMENTS

Organic Waste Transport and Assimilation

Principal sources of waste discharges in North Bald Eagle Creek below the proposed reservoir site are the New York and Pennsylvania Company, Koppers Incorporated, and the City of Lock Haven. Combined waste volumes from these sources are estimated to be 52 mgd and to have a population equivalent (P.E.) of 61,000 by the year 2020. In projecting the waste loads, it is assumed that adequate treatment will be provided at each waste source prior to discharge to the stream. Adequate treatment is defined as a minimum of 85 per cent reduction in BOD, since the wastes generated will be generally amenable to reduction in existing biological waste treatment processes.

Stream flow required to meet the dissolved oxygen objective in that reach of North Bald Eagle Creek below the proposed reservoir was calculated to be 115, 110, and 90 cfs for the critical months of July, August, and September, respectively.

It is anticipated that withdrawals from North Bald Eagle Creek will approach 70 cfs by the year 2020. Water supply withdrawal will leave a mean monthly flow of 220, 155, and 125 cfs available in the stream for waste assimilation during the critical months of July, August, and September, respectively. Available flows are based upon the annual mean discharge with a 20-year return frequency, distributed statistically to obtain the probable monthly flows. The available stream flow, water supply needs, and quality control requirements for organic waste assimilation are listed below by the critical months for the year 2020 for North Bald Eagle Creek below the proposed reservoir.

Month	20-Year Return Flow (cfs)	Water Supply Needs (cfs)	Quality Control Needs (cfs)
July	290	70	115
August	225	70	110
September	195	70	90

The tabulation indicates that stream flows in North Bald Eagle Creek exceed estimated future need by 35 to 105 cfs, depending upon the month within the critical period.

Mine Drainage

As previously indicated, the West Branch is acidic downstream to its confluence with North Bald Eagle Creek. Below this confluence, the West Branch is slightly alkaline, except during those times when acid "slugs" occur and are hydraulically transported beyond this point.

The ideal would be to prevent formation of these "slugs" by eliminating the source through an effective mine drainage program. Although the degree to which control can be achieved by various measures is largely unknown at this time, the State of Pennsylvania has made definite progress in some areas. In addition, the Public Health Service has recently undertaken a demonstration program directed to the investigation, construction, and evaluation of several control methods for abating mine drainage pollution within selected areas of the Appalachian region. Such methods as mine sealing, drainage diversion, equalizing reservoirs, and treatment are being investigated. Unfortunately, complete evaluations will not be available for several years.

In lieu of present inability to control mine drainage pollution at its source, water quality degradation may be reduced by flow regulation. Regulation of streams containing mine drainage to provide sufficient flows to continually flush the pollutants downstream, or occasional surging of the stream before build-up of critical concentrations of pollutants, might reduce "slugs." Regulated discharge of alkaline waters and complete mixing could also reduce acidity and dilute the concentrations of other pollutants. However, the quantity of alkaline water required to minimize or negate a "slug" is impossible to determine at this time. This is due to the lack of sufficient chemical data on "slugs" and to the inability at the present to perform an in-stream stoichiometric alkalinity-acidity balance. Another unknown is whether or not the materials precipitated below confluences of acid and alkaline streams will be returned to solution and/or suspended under "slug" conditions, to further aggravate the situation.

VII. BENEFITS

WATER SUPPLY

Projected municipal and industrial water supply requirements in North Bald Eagle Creek Basin for the year 2020 are estimated to be 25 and 125 mgd, respectively. An investigation of the adequacy of present sources of supply and of the availability of both ground and surface waters indicates that sufficient water is available to meet future needs. Projected withdrawals from North Bald Eagle Creek below the proposed reservoir are not expected to exceed natural, occurring, dependable stream flows (minimum day with recurrence frequency of once in 20 years) during the study period. Since no need exists for reservoir storage for municipal and/or industrial water supply, no tangible benefit can be assigned to the proposed reservoir for this purpose. Intangibly, users may benefit from more uniform flow and quality conditions.

WATER QUALITY CONTROL

The projected year 2020 waste load discharged following adequate treatment to North Bald Eagle Creek below the proposed reservoir is estimated to be 52 mgd, with a P. E. of 61,000. This study indicates that the natural occurring stream flows (minimum annual average flow with 20-year return frequency statistically distributed to indicate probable monthly flows) are sufficient to assimilate the estimated year 2020 organic waste load. There exists, therefore, no need for reservoir storage for this purpose.

It must be pointed out that the high concentrations of inorganic nitrates and phosphates presently contained in the waters of North Bald Eagle Creek, if not substantially reduced, may cause severe algal problems in the proposed reservoir. The value of the reservoir for recreation and as a fishery may be greatly impaired unless positive control measures are adopted either at the nutrient source or within the reservoir.

Mine Drainage

As previously discussed, there is insufficient knowledge of in-stream chemistry of waters containing mine drainage to determine the merits of flow regulation for water quality control. Therefore, it is not possible at this time to establish or assess a need for storage for this purpose.

Reduction or elimination of mine drainage pollutants and "slug" conditions in the West Branch would improve the aquatic environ; reduce corrosion of bridges, dams, and other submerged structures; and enhance boating and other recreational activities. An improvement in quality would increase aesthetic and property values along the West Branch below Lock Haven and make the area more suitable for industrial and municipal development. Elimination of "slug" conditions, according to the Pennsylvania Fish Commission, would possibly stop fish kills in the West Branch between Montoursville and Sunbury (about 35 miles) resulting in savings in fish life values of from $10,600 to $32,000 per mile, dependent upon frequency of occurrence.

VIII. RESERVOIR OPERATION

The storage of water in Blanchard Reservoir during flood flows and during filling of the recreation pool may have an adverse effect on the water quality of North Bald Eagle Creek below the reservoir, as well as on a reach of the West Branch. Complete closure of the reservoir gates will result in approximately a 65 per cent reduction in available alkalinity. Such a reduction would allow the acid waters of Beech Creek to govern quality in North Bald Eagle Creek to the confluence with alkaline Fishing Creek, a distance of approximately 8 miles. In addition, retaining alkaline waters would then result in an extension, for an indeterminate distance, of the acid conditions within the West Branch. In the development of the final operational plan, consideration should be given to the need for releasing sufficient flow to eliminate the possibility of producing these adverse conditions.

Since present planning by the Corps of Engineers calls for the availability of 3300 acre-feet of storage in Blanchard Reservoir for water quality control between mid-June and Labor Day, and an additional 22,500 acre-feet from Labor Day to mid-November, attempts should be made to utilize this water to negate "slug" conditions. Knowledge gained through experimental operation of the reservoir, combined with investigations designed to define the in-stream chemistry of mine drainage, will be extremely valuable in the development of future control measures.

Some difficulty may be experienced in being able to release sufficient alkalinity to overcome downstream problems because of the proposed annual filling and emptying of the reservoir. Filling of the recreational pool in the spring will likely result in storage of waters having low alkalinity concentrations because of surface run-off. In order to provide the same degree of neutralization that occurs under natural conditions, especially at low flows when North Bald Eagle Creek flows are primarily spring-fed, highly alkaline waters, releases greater than natural recurring flows will be required.

A chemical quality and flow monitoring program within the West Branch and North Bald Eagle Creek will, in all likelihood, be a necessity to insure even moderate quality control. In addition, the regulation of discharges from the proposed reservoir should be coordinated with discharges from the George B. Stevenson Reservoir on the First Fork of Sinnemahoning Creek, Alvin R. Bush Reservoir on Kettle Creek, and Curwensville Reservoir (under construction) on the West Branch Susquehanna River.

Because of vertical stratification in deep impoundments, water quality, in general, decreases with depth. The proposed reservoir should have an outlet structure which will allow discharge of water from several depths. Such a structure would be a means for selecting water of the best quality and for mixing waters from various levels. The net result is better control of the discharge to meet downstream quality requirements.

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Table 8

MUNICIPAL WATER SUPPLIES
NORTH BALD EAGLE CREEK BASIN

Municipality	Population Served	Gallons Per Day Ground	Surface
Beech Creek B.W.W.	1,200	---	100,000
Bellefonte B.A.	10,000	3,300,000	---
Benner Township			
(Rockview Pen)	1,200	70,000	200,000
College Township			
(Lement Water Co.)	3,200	500,000	---
(Oak Hall W.S.)	240	---	1,000
Curtain Township			
(General Refractories)	250	---	15,000
Ferguson Township			
(Pine Grove W. Co.)	600	---	20,000
Harris Township			
(Boalsburg W. Co.)	1,500	---	150,000
Howard W.W.	800	---	80,000
Lamar Township			
(Mackeyville W. Co.)	250	---	50,000
(Rote Mutual W. Co.)	225	19,200	---
Liberty Township			
(STD Real Estate)	350	---	25,000
Logan Township			
(Booneville M.W.A.)	180	8,000	---
(Greenburg W.A.)	50	---	6,000
(Tylersville M.W.A.)	355	15,000	---
Lock Haven C.A.	11,600	---	2,545,000
Suburban Lock Haven			
Water Authority	8,300	---	1,000,000
Milesburg B.A.	1,000	---	100,000
Porter Township			
(Clintondale W.C.O.)	250	10,000	---
Port Matilda W.W.	700	40,000	---
Snow Shoe Township			
(Clarence W.C.O.)	1,150	20,000	100,000
Spring Township			
(Coleville W.C.O.)	400	15,000	---
(Pleasant Gap W.C.O.)	2,000	47,500	47,500
State College			
(Penn State Univ.)	16,000	2,212,000	168,000
State College B.A.	17,000	1,200,000	300,000
Unionville M.W.W.	325	17,000	---
Walker Township			
(Nittany W.C.O.)	1,000	---	50,000
(Nittany C.C.)	60	---	2,000
(Walker Twp W.A.)	525	---	12,000
Total - 29 supplies	80,710	7,473,700	4,971,500

EXHIBIT A

Table 9

MAJOR INDUSTRIAL WATER USERS
NORTH BALD EAGLE CREEK BASIN

Industry	Gallons Per Day Ground	Surface	Municipal
Bald Eagle Chemical Corporation	---	17,000	---
Bellefonte Lime	1,000	293,000	---
Bloomsburg Mills, Inc.	---	---	17,000
Centre County Canning Company	84,000	---	---
Cerro Copper and Brass Company	440,000	---	60,000
Crissman Bros. Abbatior	---	5,000	---
Dotterer Farms Dairy	2,000	---	---
General Armuture	---	---	9,000
General Refractories	---	42,000	---
Kilsdonk Chemical Corporation	---	---	125,000
Koppers Company, Inc.	600,000	---	1,405,000
Kyle's Dairy Farms	---	---	15,000
Meadow Pride Dairy	---	---	15,000
National Gypsum Company	450,000	70,000	---
Nease Chemical Company	---	---	150,000
New York and Pennsylvania Company	---	53,000,000	765,000
Piper Aircraft Corporation	---	---	200,000
Sealtest Foods, Inc. (Mill Hall)	---	---	5,000
Sealtest Foods, Inc. (Bellefonte)	---	---	8,000
Standard Lime and Cement Company	54,000	---	---
Taylor Potato Chip Company	---	---	1,000
Warner Company	---	---	20,000
West Penn Power Company	---	43,000,000	14,000
Winner Packing Company	---	---	33,000
TOTALS	1,631,000	96,427,000	2,842,000

EXHIBIT B

Table 10

PRINCIPAL SOURCES OF MUNICIPAL WASTE
NORTH BALD EAGLE CREEK BASIN

Municipality	Population Served	MGD	Treatment	P. E. Discharge
Bellefonte M.S.A.	6,088	1.400	Secondary	750
Benner Township (Rockview Pen)	1,163	0.250	Secondary	410
Boggs Township (Bald Eagle J.A. School)	1,850	0.001	Secondary	1
Lock Haven M.S.A.	15,000	1.300	Primary	7,640
State College (Pennsylvania State Univ.*)	36,000	2.800 0.060	Secondary Land Application	4,110 0
TOTALS	60,101	5.811		12,911

* Includes Pennsylvania State University and State College Borough.

Table 11

PRINCIPAL SOURCES OF INDUSTRIAL WASTE
NORTH BALD EAGLE CREEK BASIN

Industry	MGD	Treatment	Receiving Stream
Bald Eagle Chemical Corp.	0.009	Closed Lagoon	Not Applicable
Bellefonte Lime			
Cooling water	0.216	None	Buffalo Run
Silt waste	0.450	None	Buffalo Run
Bloomsburg Mills, Inc.	0.012	Municipal Sewers	Not Applicable
Centre County Canning Co.	0.045	Spray Irrigation	Not Applicable
Cerro Copper and Brass Co.			
Rinse water	0.343	Complete	Logan Branch
Plating waste	0.186	Closed Lagoon	Not Applicable
Sanitary waste	0.060	Municipal Sewers	Not Applicable
Crissman Bros. Abbatior	0.005	Primary	N. Bald Eagle
Dotterer Farms Dairy	0.002	Spray Irrigation	Not Applicable
Kilsdonk Chemical Corp.			
Dye waste	0.012	Closed Lagoon	Not Applicable
Cooling water	0.164	Municipal Sewers	Not Applicable
Koppers Company, Inc.	2.000	Complete	N. Bald Eagle
Kyle's Dairy Farms			
Milk waste	0.008	Municipal Sewers	Not Applicable
Cooling water	0.007	None	Duck Run
Meadow Pride Dairy			
Milk waste	0.005	Municipal Sewers	Not Applicable
Cooling water	0.010	None	Thompson Run
Nease Chemical Co.			
Chemical waste	0.006	Lagoons	Not Applicable
Cooling water	0.143	None	Spring Creek
New York and Pennsylvania Co.			
Paper mill waste	23.000	Primary	N. Bald Eagle
Cooling water	30.000	None	N. Bald Eagle
Piper Aircraft Corp.	0.200	Municipal Sewers	Not Applicable
Sealtest Foods, Inc.	0.013	Municipal Sewers	Not Applicable
Standard Lime & Cement Co.	0.042	Closed Lagoon	Not Applicable
Taylor Potato Chip Co.	0.001	None	T. Spring Creek
Warner Company	0.019	Silt Basins	Buffalo Run
West Penn Power Co.			
Cooling water	43.100	None	Spring Creek
Boiler ash	0.100	Silt Basins	N. Bald Eagle
Winner Packing Co.	0.025	Municipal Sewers	Not Applicable
TOTAL	100.183		

EXHIBIT C

Table 12

STREAM FLOW DATA

GAGING STATIONS

Station Number	Stream	Location	Average Discharge cfs	Years of Record
1-5455	West Branch Susquehanna River	at Renovo	4,929	56
1-5515	West Branch Susquehanna liver	at Williamsport	8,837	68
1-5475	North Bald Eagle Creek	at Blanchard	454	9
1-5480	North Bald Eagle Creek	at Beech Creek Station	792	53
1-5477	Marsh Creek	at Blanchard	51	8

DATA ANALYSIS

To obtain a representative flow of the North Bald Eagle Creek at its confluence with the West Branch of the Susquehanna River, a method employed by the USGS was used. The method is empirical and assumes an observed relationship in the upper portion of the Basin to hold true in the lower reaches of the Basin.

The flow in the West Branch of the Susquehanna River at Lock Haven was derived by correlating the discharge between Renovo and Williamsport at various ranges of daily flow crest. Lag times were observed for each station, and the flow adjusted according to a ratio of drainage areas.

EXHIBIT C

Table 13

MEAN MONTHLY FLOWS
NORTH BALD EAGLE CREEK BASIN

Month	North Bald Eagle Creek at Blanchard cfs	Beech Creek at Confluence cfs	North Bald Eagle Creek at Beech Creek Station cfs	North Bald Eagle Creek at Confluence cfs
October	250	120	390	500
November	360	220	605	840
December	390	250	675	920
January	475	330	855	1,200
February	530	345	935	1,350
March	870	660	1,670	2,400
April	820	620	1,590	2,250
May	650	410	1,200	1,720
June	355	220	600	840
July	235	110	365	470
August	195	75	285	360
September	160	45	210	255

EXHIBIT C

Table 14

MEAN MONTHLY FLOWS
WEST BRANCH OF THE SUSQUEHANNA RIVER

Month	West Branch at Renovo cfs	West Branch at Lock Haven cfs	West Branch at Station Seven cfs	West Branch at Williamsport cfs
October	2,050	2,150	2,650	3,800
November	3,565	3,740	4,580	6,300
December	4,500	4,700	5,620	7,955
January	6,325	6,700	7,900	10,165
February	5,830	6,100	7,450	9,915
March	11,545	12,000	14,400	20,670
April	10,360	11,000	13,250	18,710
May	7,335	7,600	8,320	12,780
June	3,630	3,820	4,660	6,800
July	1,295	1,390	1,860	3,870
August	1,250	1,350	1,710	2,670
September	1,220	1,300	1,550	2,355

EXHIBIT C

Table 15

MEAN MONTHLY FLOWS AND FLOW RATIOS FOR
NORTH BALD EAGLE CREEK AND WEST BRANCH SUSQUEHANNA AT LOCK HAVEN

Month	West Branch at Lock Haven cfs	North Bald Eagle at Confluence cfs	Ratio of West Branch to North Bald Eagle Creek
October	2,150	500	4:1
November	3,740	840	4:1
December	4,700	920	5:1
January	6,700	1,200	6:1
February	6,100	1,350	5:1
March	12,000	2,400	5:1
April	11,000	2,250	5:1
May	7,600	1,720	4:1
June	3,820	840	5:1
July	1,390	470	3:1
August	1,350	360	4:1
September	1,300	255	5:1

EXHIBIT D

ANALYSIS OF WATER QUALITY DATA

METHODS OF SAMPLING, ANALYZING, AND REPORTING

Pennsylvania Department of Health

The Pennsylvania Department of Health's current water quality network, consisting of 176 stations, was established in May of 1962. These stations are sampled at quarterly intervals using the "grab" technique. Where stratification is evident, the stream is sampled at various points and composited. From 1950 to 1960, the PHD conducted a stream survey in the bituminous coal areas of the state. Sampling procedures were similar to those used in current water quality network.

The samples from these surveys and other samples were analyzed using procedures outlined in Standard Methods except for the acidity and alkalinity determinations. The concentration of alkalinity is determined potentiometrically by titrating with a standardized acid to an end point of pH 4.0. The concentration of acidity is measured potentiometrically on a heated sample titrating with a standardized base to end points of pH 4.0 and pH 8.0. The acidity and alkalinity concentrations are reported in mg/l of $CaCO_3$. Data for the various PHD stations within the area of influence of North Bald Eagle Creek Basin are tabulated in Exhibit F.

U. S. Geological Survey

The USGS has maintained various numbers of sampling stations within North Bald Eagle Creek Basin since 1946. The station on the West Branch at Lock Haven was sampled consistently from 1946 to 1951 and continuously sampled at monthly intervals since 1958. Other stations, established at later dates, were sampled at less frequent intervals. The station on the North Bald Eagle Creek near Blanchard was established in 1955 with samples taken at monthly intervals.

The sampling methods vary from a single "grab" to a ten-day composite and/or a cross sectional composite. The samples were analyzed according to procedure given in the USGS Water Supply Paper 1454. The analysis procedures are generally similar to that of Standard Methods, except for alkalinity and acidity determinations. Alkalinity concentration is determined by titrating with a standardized acid to end points of pH 8.2 and pH 4.5

and are reported as either bicarbonate ion or $CaCO_3$. Acidity concentration (total acidity) is determined by titrating a cold sample with a standardized base to an end point of pH 7.0, heating the solution to 80° - 90° C., cooling to room temperature, and continuing titrating to an end point of pH 7.0. The acidity is reported in terms of hydrogen ion concentration. Data for the various USGS stations within the North Bald Eagle Creek Basin are presented in Exhibit F.

New York and Pennsylvania Company

The New York and Pennsylvania Company has conducted 45 summer stream surveys since 1950. The paper company established four sampling stations on the North Bald Eagle Creek and six stations on the West Branch of the Susquehanna River. The paper company also monitors its process water taken from North Bald Eagle Creek above the confluence with Fishing Creek.

All samples were taken using the "grab" technique with no compositing, and analyses are made according to Standard Methods. The titration end point of 4.6 was used for alkalinity determinations. The data are tabulated in Exhibit F.

DATA INTERPRETATION

A review of the original data as reported by the above agencies indicates there is a difference in the methodology of reporting various chemical determinations. When differences existed, the data were reduced to a common base. For example, concentrations of acidity which were reported as both $CaCO_3$ and hydrogen ion were converted to a common base of $CaCO_3$. The original data are presented in Exhibit F, with the data converted to common bases shown in Tables 5 and 6.

The acidity content in Beech Creek and the West Branch above Lock Haven and the alkalinity content in North Bald Eagle Creek and the West Branch below Lock Haven were determined for each month. A flow versus concentration of alkalinity or acidity was established graphically. A line of best fit was determined by a variation of the method of "averages."

For each station, the pounds of alkalinity or acidity were calculated for each month by multiplying the mean monthly flows times the concentration (obtained from the graph) by a conversion factor. The concentration and pounds of alkalinity or acidity for each station are shown in Tables 5 and 6.

Even though acidity and alkalinity determinations were reduced to a common base, $CaCO_3$, inherent differences in analytical methods, sampling procedures, etc., preclude a stoichiometric acid-alkaline balance at this time. In review of the data, three idiosyncrasies in the alkalinity and/or acidity data can be seen.

1. The acidity data, as reported by the USGS and PHD for similar sampling stations, is not comparable because of differences in titration end points.

2. Present acidity and alkalinity determinations, because of differences in analytical end points, yield data not suitable for quantitative balances.

3. After the mixing of acid and alkaline water in a stream, the resulting end point is at an intermediate pH value. Thus, the stream can exhibit both alkalinity and acidity at the same time. Analysis procedures used by the reporting agencies did not report both acidity and alkalinity concentrations at intermediate pH values.

If, in the future, sampling and analytical methods can be standardized, intermediate determinations made, and the kinetics of acid-alkaline reactions understood, it may be possible to do a stoichiometric balance. More research is needed to fully understand the chemistry of mine drainage pollution.

EXHIBIT E

PENNSYLVANIA DEPARTMENT OF HEALTH
WATER QUALITY OBJECTIVES AND CRITERIA

The Pennsylvania Department of Health has recommended the following objectives and criteria:

Bald Eagle Creek: Beech Creek to Mouth

Objective: The establishment of conditions

1. suitable for industrial and domestic water supply, propagation of game fish, and recreational uses.

2. conducive to maintenance of the stream's present high alkalinity and excellent game fish habitat.

Criteria:

1. pH range - between 6.5 and 8.5

2. Alkalinity as $CaCO_3$ monthly median not less than 100 mg/l, minimum concentration 80 mg/l.

3. Iron - less than 0.1 mg/l.

4. Manganese - less than 0.05 mg/l.

5. Sulfate - monthly average less than 30 mg/l.

6. Phosphate - less than 0.01 mg/l.

7. Dissolved oxygen - monthly average not less than 6.5 mg/l - minimum concentration 5.0 mg/l.

West Branch, Susquehanna River: Bald Eagle Creek to Mouth

Objective: The establishment of conditions

1. suitable for industrial and domestic water supplies, fish propagation, and recreational uses.

EXHIBIT E

2. conducive to reduction of acid and iron concentrations and elimination of periodic acid conditions.

Criteria:

1. pH range - between 6.5 and 8.5.
2. Alkalinity as $CaCO_3$ monthly median not less than 20 mg/l, minimum concentration 10 mg/l.
3. Iron - less than 0.3 mg/l.
4. Manganese - less than 0.3 mg/l.
5. Sulfate - less than 250 mg/l.
6. Dissolved oxygen - monthly average not less than 6.5 mg/l - minimum concentration 5.0 mg/l.

EXHIBIT F

WATER QUALITY DATA

Table 16

SAMPLING STATIONS

Agency	Station No.	Stream	Location
USGS	015475	North Bald Eagle	Blanchard
USGS	015479	Beech Creek	Beech Creek
USGS	015480	North Bald Eagle	Mill Hall
USGS	015458	West Branch Susquehanna River	Lock Haven
PHD	Special	North Bald Eagle	Liberty Township
PHD	Special	North Bald Eagle	Mill Hall
PHD	Special	Beech Creek	Beech Creek
PHD	4-13 WQN	North Bald Eagle	Howard Township
PHD	4-12 WQN	North Bald Eagle	Mill Hall
PHD	4-3 WQN	West Branch Susquehanna River	Renovo
PHD	4-2 WQN	West Branch Susquehanna River	Williamsport
PHD	Bit. Survey No. 3	West Branch Susquehanna River	Renovo
PHD	Bit. Survey No. 4	West Branch Susquehanna River	Williamsport
N. Y. & Pa. Co.	Water Intake	North Bald Eagle	Mill Hall
N. Y. & Pa. Co.	No. 4	North Bald Eagle	Near confluence
N. Y. & Pa. Co.	No. 7	West Branch Susquehanna River	Below confluence with North Bald Eagle

EXHIBIT F

Table 17

TABULATION OF SURVEY RESULTS
U. S. GEOLOGICAL SURVEY
NORTH BALD EAGLE CREEK AT BLANCHARD

Date	Flow cfs	Temp. °F	Fe mg/l	Mn. mg/l	HCO_3 mg/l	SO_4 mg/l	NO_3 mg/l	Dissolved Solids mg/l	Alk. as $CaCO_3$ mg/l	pH
10-11-56	246	53.5	0.01	0.00	162	19	6.1	184	136	8.5
01-02-57	425	35	.02	0.00	136	19	7.0	164	118	8.4
10-28-58	191	--	0.00	0.00	165	19	7.5	157	135	7.4
12-14-58	185	33	--	--	132	20	5.7	--	108	7.8
04-14-59	837	51	0.00	0.00	73	19	3.0	116	60	7.7
05-25-59	276	68	--	--	131	19	5.1	180	108	7.9
07-16-59	154	80	0.00	0.06	170	21	4.8	238	154	8.1
08-20-59	127	75	--	--	172	19	5.2	170	141	7.7
10-02-59	172	67	--	--	158	21	7.5	208	130	7.9
11-18-59	272	38	0.00	0.00	132	22	7.6	159	108	7.6
12-16-59	781	--	--	--	88	25	4.6	123	72	7.8
01-28-60	326	--	0.01	0.03	133	25	7.8	180	109	8.2
04-18-60	464	--	0.01	0.03	138	23	8.5	183	113	7.7
06-06-60	550	--	--	0.02	128	20	4.8	174	105	7.8
07-11-60	271	68	--	--	184	20	5.8	190	151	8.0
09-01-60	167	77	--	--	173	23	6.5	190	142	7.6
10-10-60	155	60	0.01	0.01	186	23	7.0	--	152	7.9
11-16-60	158	49	0.00	--	178	18	7.4	171	146	7.9
12-29-60	130	--	--	--	174	23	5.6	236	142	8.0
02-17-61	278	38	0.02	0.00	112	26	6.1	168	92	6.7
03-20-61	615	42	0.00	--	100	19	4.5	101	82	7.4
06-01-62	214	--	0.01	0.03	172	22	--	169	141	7.9
06-25-62	200	--	0.01	0.03	187	22	1.0	248	153	7.2
08-01-62	125	75	0.00	0.00	192	18	5.9	200	157	8.3
09-14-62	127	--	0.01	0.02	186	20	2.3	189	152	7.6
09-18-62	125	--	0.01	0.01	187	19	2.8	204	153	7.8
10-05-62	694	59	0.01	0.09	84	31	1.7	148	69	7.2

EXHIBIT F

Table 17 (continued)

Date	Flow cfs	Temp. °F	Fe mg/l	Mn. mg/l	HCO_3 mg/l	SO_4 mg/l	NO_3 mg/l	Dissolved Solids mg/l	Alk. as $CaCO_3$ mg/l	pH
10-31-62	176	50	0.02	0.07	161	25	2.0	212	132	7.4
12-10-62	182	--	--	--	127	24	--	--	104	7.2
12-14-62	160	32	0.00	0.00	148	33	7.4	227	121	7.8
01-23-63	180	--	0.02	0.02	116	22	2.9	135	95	7.6
03-07-63	1,350	37	0.00	0.00	55	21	5.5	105	45	7.0
04-12-63	310	53	0.00	0.00	122	18	5.1	153	100	7.8
05-01-63	287	--	0.02	0.00	114	21	1.1	157	94	8.0
06-04-63	260	66	0.02	0.00	122	19	5.5	154	100	7.2

EXHIBIT F

Table 18

TABULATION OF INTAKE WATER QUALITY
NEW YORK AND PENNSYLVANIA COMPANY
NORTH BALD EAGLE CREEK NEAR MILL HALL
(Above the confluence with Fishing Creek)

Date	Flow cfs	pH	Hardness as $CaCO_3$ mg/l	Alk. as $CaCO_3$ mg/l	Fe mg/l	Mn. mg/l
12-31-63	150	7.4	128	80	--	--
12-23-63	210	7.4	122	72	--	--
12-11-63	393	7.2	90	52	--	--
12-05-63	403	7.0	80	38	--	--
11-26-63	170	7.7	138	80	--	--
11-18-63	150	7.6	160	114	--	--
11-11-63	208	7.4	122	66	--	--
11-07-63	320	7.8	150	118	--	--
10-31-63	117	8.2	174	120	--	--
10-22-63	124	8.4	162	130	--	--
10-16-63	124	8.3	166	120	--	--
10-12-63	124	8.3	172	114	--	--
08-22-63	482	7.9	146	114	0.3	--
07-26-63	588	8.0	132	86	0.4	--
04-17-63	2,540	8.1	92	61	0.3	--
04-03-63	12,800	7.1	60	30	0.5	--
02-20-63	1,200	7.8	104	64	0.4	--
02-07-63	1,600	7.3	102	58	0.2	--
01-24-63	2,300	7.4	80	46	0.6	0.4
01-17-63	5,800	7.2	58	26	0.3	0.4
01-03-63	970	7.6	106	64	0.4	0.5
12-06-62	1,600	7.6	104	60	0.7	0.6
11-28-62	1,730	7.4	92	50	0.3	0.6
11-15-62	3,120	7.1	70	28	0.5	0.6
11-08-62	1,650	7.3	112	54	0.3	0.7
10-31-62	1,420	7.3	146	68	0.3	1.1
10-24-62	731	7.4	138	64	--	--
10-22-62	819	7.3	140	56	--	--
10-19-62	902	7.2	135	49	0.3	1.4
10-17-62	1,070	7.3	126	42	0.5	1.4
10-04-62	1,340	7.5	148	70	0.5	0.6
09-12-62	185	7.8	162	116	0.5	0.1
09-04-62	166	8.0	164	122	1.25	0.2
08-15-62	170	7.9	164	115	0.7	0.2

EXHIBIT F

Table 18 (continued)

Date	Flow cfs	pH	Hardness as $CaCO_3$ mg/l	Alk. as $CaCO_3$ mg/l	Fe mg/l	Mn. mg/l
07-26-62	155	7.9	154	114	0.5	0.1
06-28-62	212	7.7	140	94	1.20	0.43
06-20-62	250	7.7	132	86	1.0	0.3
05-22-62	398	8.0	110	78	1.25	0.45
05-09-62	590	8.0	100	66	0.6	0.5
05-02-62	747	7.8	100	64	1.0	--
04-18-62	1,830	7.2	70	38	0.7	0.4
04-11-62	2,410	7.3	56	30	0.5	0.3
04-04-62	2,550	7.0	50	22	0.5	--
03-27-62	3,150	7.2	50	24	0.7	0.3
03-20-62	1,950	7.5	66	40	1.1	--
03-15-62	2,080	7.4	58	38	1.5	0.2
03-07-62	745	7.3	78	42	--	--
02-27-62	2,290	7.4	78	40	1.25	0.1
02-15-62	250	7.6	102	78	--	--
01-31-62	490	7.4	68	38	0.5	0.45
01-17-62	380	7.5	86	54	--	--
01-10-62	370	7.4	80	46	0.75	0.3
01-02-62	212	7.4	114	70	--	--
12-29-61	230	7.4	96	54	--	--
11-28-61	254	7.9	110	62	0.5	0.55
11-14-61	196	7.9	158	114	--	--
11-09-61	166	8.0	154	112	0.6	0.25
10-24-61	158	8.1	168	126	0.75	0.2
10-17-61	158	8.0	158	116	1.0	0.3
10-10-61	155	8.1	154	120	1.0	0.25
09-27-61	378	8.4	160	116	0.5	0.2
08-15-61	224	8.0	132	90	0.75	0.5
07-21-61	299	8.0	134	98	--	--
07-13-61	761	7.6	136	94	--	--
07-12-61	939	8.0	134	98	0.75	0.4
06-27-61	638	7.8	110	76	--	--
06-20-61	994	8.1	102	74	--	--
06-14-61	994	7.7	76	54	0.5	0.25
06-07-61	364	8.4	110	78	0.25	0.25
05-31-61	477	8.5	102	68	1.0	0.2
05-18-61	1,020	7.7	78	48	--	--
05-09-61	1,390	7.6	92	64	--	--
04-28-61	1,380	7.4	76	50	--	--
04-19-61	2,780	7.2	56	28	0.75	0.35

EXHIBIT F

Table 18 (continued)

Date	Flow cfs	pH	Hardness as $CaCO_3$ mg/l	Alk. as $CaCO_3$ mg/l	Fe mg/l	Mn. mg/l
04-07-61	1,160	7.6	74	44	--	--
03-31-61	1,430	7.5	66	38	--	--
03-22-61	1,180	7.5	78	40	0.75	0.55
03-15-61	1,770	7.6	78	44	0.75	0.45
03-03-61	1,890	7.3	66	36	--	--
03-22-61	1,650	7.4	62	30	0.75	0.35
02-15-61	260	8.1	122	84	--	--
02-07-61	210	7.7	130	94	--	--
02-01-61	200	7.8	132	90	0.25	0.35
01-25-61	245	7.8	130	82	0.25	0.45
01-18-61	293	7.9	116	76	0.25	0.4
01-11-61	271	7.8	122	80	0.5	0.4
01-04-61	200	7.8	138	96	0.35	0.45
12-29-60	185	7.7	150	102	0.3	0.5
12-23-60	160	8.1	148	104	--	--
12-16-60	210	7.9	152	104	--	--
12-05-60	233	7.7	138	98	--	--
11-30-60	260	8.1	150	104	0.8	0.4
11-23-60	216	8.5	150	104	0.5	0.5
11-16-60	225	8.2	146	96	0.5	0.7
10-26-60	173	8.0	164	106	0.3	0.6
10-09-60	173	8.1	161	116	0.5	0.5
09-30-60	208	7.6	166	110	--	--
09-15-60	275	7.6	140	96	--	--
09-07-60	185	7.8	168	121	0.3	0.4
08-23-60	212	7.7	152	96	--	--
08-18-60	216	7.8	142	98	--	--
08-12-60	237	7.8	152	101	--	--
08-02-60	254	7.8	134	84	--	--
07-28-60	382	7.9	128	54	--	--
07-15-60	1,660	7.4	84	52	1.0	0.5
06-29-60	398	7.8	84	48	0.8	0.3
06-14-60	722	7.5	104	74	0.7	0.5

EXHIBIT F

Table 19

TABULATION OF SURVEY RESULTS
U. S. GEOLOGICAL SURVEY
NORTH BALD EAGLE CREEK AT MILL HALL

Date	Flow cfs	Temp. °F	pH	Fe mg/l	Mn. mg/l	Alk. as $CaCO_3$* mg/l	SO_4 mg/l	NO_3 mg/l
08-01-62	144	75	7.9	0.00	0.00	129	37	4.0
09-14-62	155	--	7.2	0.00	0.01	115	52	1.0
10-05-62	1,580	59	6.9	0.01	0.09	27	56	1.7
10-31-62	316	46	6.8	0.02	0.29	61	69	1.8
12-10-62	310	--	6.9	--	--	53	43	--
03-07-63	1,860	37	6.7	0.00	0.02	40	26	5.9
04-12-63	563	49	7.5	0.01	0.28	44	38	0.6
05-01-63	440	50	7.9	0.01	0.06	58	33	0.8
06-04-63	597	63	6.9	0.02	0.00	38	34	2.0

* Reported as HCO_3 - original values were multiplied by ratio of equivalent weights to obtain figures shown.

EXHIBIT F

Table 20

TABULATION OF SURVEY RESULTS
NEW YORK AND PENNSYLVANIA COMPANY
NORTH BALD EAGLE CREEK AT STATION 4
(Near confluence with West Branch of Susquehanna River)

Date	Survey Number	Flow cfs	pH	Alkalinity as $CaCO_3$ mg/l
09-19-62	45	173	7.4	138
08-08-62	44	200	7.4	133
07-05-62	43	221	7.8	109
06-06-62	42	420	7.4	99
09-27-61	41	190	7.7	133
08-23-61	40	240	7.5	129
07-19-61	39	290	7.3	108
06-21-61	38	570	7.9	86
08-23-60	37	255	7.6	124
07-21-60	36	840	7.7	53
06-21-60	35	780	7.9	70
09-23-59	34	170	7.2	137
08-19-59	33	170	7.7	137
07-22-59	32	265	7.4	106
09-20-58	31	268	7.4	110
08-21-58	30	310	7.5	120
08-28-57	29	175	7.3	146
07-25-57	28	265	7.4	146
09-27-56	27	430	7.4	96
08-30-56	26	680	7.4	66
07-26-56	25	1,050	7.5	59
06-28-56	24	840	7.7	61
10-14-54	18	180	7.2	146
09-14-54	17	160	7.4	147
08-11-54	16	245	7.6	125
07-08-54	15	440	7.6	91
06-21-54	14	440	7.5	100
10-28-53	13	175	7.6	126
09-25-53	12	163	7.7	121
08-26-53	11	165	7.4	125
07-21-53	10	260	7.5	106
06-23-53	9	570	7.5	92
09-28-50	4	220	7.1	99
08-30-50	3	285	7.3	78
07-20-50	2	360	7.6	73

EXHIBIT F

Table 21

TABULATION OF SPECIAL SURVEY RESULTS
PENNSYLVANIA DEPARTMENT OF HEALTH
NORTH BALD EAGLE CREEK BASIN

Date	Flow cfs	pH	Acid as $CaCO_3$ mg/l	Alk. as $CaCO_3$ mg/l	Fe mg/l
North Bald Eagle Creek in Liberty Township					
08-08-63	121	8.3	0	152	0.4
06-12-63	407	7.1	0	72	2.0
05-27-63	485	7.0	0	76	0.6
05-02-63	288	8.7	0	104	0.0
11-15-62	283	7.2	0	105	0.2
09-25-62	116	7.9	0	160	0.6
08-28-62	125	8.1	0	150	1.2
02-15-59	1,500	--	-	--	--
12-19-58	168	7.8	0	120	--
North Bald Eagle Creek near Mill Hall					
08-08-63	148	7.8	0	110	0.0
06-12-63	770	6.2	0	38	0.2
05-27-63	1,080	6.3	0	37	0.4
05-02-63	424	7.5	0	60	0.0
11-15-62	861	7.0	0	34	0.0
09-25-62	144	7.3	0	135	0.2
08-28-62	144	7.9	0	110	0.4
02-15-59	2,390	--	-	--	--
12-19-58	344	7.4	0	130	--
Beech Creek near Beech Creek Station					
08-08-63	23.4	4.1	40	4	0.0
06-12-63	328	4.6	24	6	0.2
05-27-63	901	4.6	10	6	0.4
05-02-63	116	4.8	20	6	0.2
11-15-62	478	4.4	24	4	0.2
09-25-62	36	5.8	86	0	0.2
08-28-62	10.3	4.0	--	0	0.4
02-15-59	1,690	4.6	18	5	0.4
12-19-58	--	--	--	--	--

EXHIBIT F

Table 22

TABULATION OF SURVEY RESULTS
U. S. GEOLOGICAL SURVEY
BEECH CREEK AT BEECH CREEK

Date	Flow cfs	Temp. °F	pH	Fe mg/l	Mn. mg/l	Acid as H_2SO_4* mg/l	SO_4 mg/l	NO_3 mg/l
05-28-62	103	--	4.0	0.06	1.6	19.6	78	0.3
06-30-62	46	--	3.85	0.08	2.7	39.2	123	0.0
08-01-62	29	--	3.95	0.00	2.8	34.3	163	0.5
09-14-62	25	--	4.1	0.17	4.5	68.6	220	0.2
10-05-62	550	58	4.4	0.03	2.8	34.3	114	0.2
10-31-62	149	48	3.9	0.06	3.8	53.4	154	0.2
12-10-62	154	--	4.3	-	--	29.4	86	--
03-07-63	407	32	4.7	0.00	1.8	--	80	0.9
04-12-63	286	48	4.35	0.02	1.4	19.6	65	0.0
05-01-63	359	45	4.4	0.02	0.6	19.6	67	0.2
06-04-63	286	60	4.5	0.02	1.1	19.6	53	0.2

* Reported as H^+ - original values were multiplied by ratio of equivalent weights to obtain figures shown.

EXHIBIT F

Table 23

TABULATION OF WATER QUALITY NETWORK RESULTS
PENNSYLVANIA DEPARTMENT OF HEALTH
NORTH BALD EAGLE CREEK BASIN

Date	Flow cfs	Field D.O. mg/l	Field pH	Alk. as $CaCO_3$ mg/l	BOD mg/l	Fe mg/l	SO_4 mg/l	ABS mg/l	PO_4 mg/l	Coliform mpn/100 cc
North Bald Eagle Near Mill Hall										
05-22-62	398	10.0	7.6	76	1.0	0.1	43	0.00	0.00	3.9×10^3
08-13-62	152	9.0	7.6	120	1.8	0.0	44	0.09	0.21	3.0×10^2
10-07-62	670	15.0	6.8	135	4.6	0.2	60	0.10	0.21	4.3×10^2
02-19-63	280	11.8	7.4	120	1.8	0.1	22	0.12	0.43	9.1×10^1
05-14-63	424	10.8	7.4	54	2.6	0.0	35	0.00	0.00	2.3×10^2
08-16-63	241	8.0	7.8	105	2.5	0.0	53	0.00	0.00	3.6×10^1
11-14-63	185	12.2	7.2	88	2.2	0.0	62	0.00	0.10	9.3×10^2
02-07-64	--	11.8	6.8	48	2.2	0.1	48	0.05	0.00	4.6×10^4
North Bald Eagle in Howard Township (upstream from proposed reservoir)										
05-22-62	209	12.0	8.0	135	4.2	0.1	24	0.11	0.29	7.3×10^3
08-13-62	95	9.0	7.4	160	3.2	1.2	22	0.16	0.57	9.3×10^3
10-07-62	245	15.8	7.8	180	3.0	0.1	24	0.12	0.70	4.3×10^2
02-14-63	169	14.0	7.6	120	1.4	0.0	14	0.20	0.70	2.3×10^2
05-19-63	171	12.6	8.0	110	2.0	0.0	17	0.12	4.60	1.5×10^2
08-16-63	127	9.0	7.8	160	1.6	0.2	20	0.05	0.35	7.5×10^2
11-12-63	--	12.0	8.0	135	0.8	0.6	24	0.50	0.70	1.1×10^4
02-06-64	--	11.6	7.6	100	1.8	0.0	24	0.10	0.30	4.6×10^3

EXHIBIT F

Table 24

BITUMINOUS SURVEY RESULTS
PENNSYLVANIA DEPARTMENT OF HEALTH
WEST BRANCH SUSQUEHANNA AT RENOVO

Date	Flow cfs	pH	Alk. as $CaCO_3$ mg/l	Acid as $CaCO_3$ mg/l	Fe mg/l	SO_4 mg/l
03-21-50	5,160	3.8	0	24	2.4	66
05-22-50	6,470	3.9	0	14	0.3	54
07-18-50	1,350	3.4	0	34	0.2	80
10-13-50	745	3.8	0	40	0.4	49
02-20-51	11,200	5.8	4	12	2.0	49
04-10-51	6,610	4.7	10	10	0.7	51
06-05-51	2,420	4.3	5	10	0.2	82
08-14-51	1,610	3.8	0	56	0.6	215
10-16-51	210	3.3	0	100	1.0	240
11-25-51	2,700	4.4	5	16	1.1	56
02-27-52	2,460	3.2	0	28	1.5	88
04-30-52	4,330	4.2	1	12	0.5	48
07-01-52	606	3.5	0	48	2.0	160
09-11-52	250	3.2	0	90	0.8	268
10-23-52	245	3.4	0	88	2.4	330
12-16-52	5,100	4.4	4	8	3.0	38
02-24-53	8,700	4.4	2	8	1.6	31
04-21-53	8,000	4.5	4	14	1.6	80
06-26-53	1,240	3.6	0	36	0.3	104
09-21-53	915	3.4	0	100	1.0	175
08-12-54	5,100	4.4	4	20	1.8	52
07-20-54	686	3.6	0	48	0.2	152
10-31-54	770	3.6	0	36	0.4	145
07-14-55	956	3.6	0	46	0.4	140
11-01-55	3,560	5.1	9	6	0.4	46
06-10-58	7,700	4.5	2	10	3.8	48
07-21-58	4,290	3.6	0	34	1.0	120
08-12-58	3,020	3.7	0	38	0.8	120
09-09-58	3,220	4.2	1	22	0.2	120
02-05-59	5,100	4.4	5	10	1.2	28
07-30-59	475	3.48	0	100	0.0	202
08-27-59	735	3.32	0	60	1.1	140
11-17-59	3,120	4.5	6	14	3.3	76
03-25-60	1,300	3.75	0	36	6.7	125
06-15-60	33,900	4.58	6	2	21.3	27
09-14-60	1,990	3.6	0	58	0.5	196

EXHIBIT F

Table 25

TABULATION OF SURVEY RESULTS, 1946-1951
U. S. GEOLOGICAL SURVEY
WEST BRANCH SUSQUEHANNA RIVER AT LOCK HAVEN

Date	Flow cfs	pH	Fe mg/l	Mn. mg/l	Acid as H_2SO_4* mg/l	SO_4 mg/l
Oct. 1-10, 1946	1,468	3.85	0.06	0.68	27	96
Oct. 11-20	3,365	3.80	.06	.60	27	88
Oct. 21-31	6,857	4.25	.02	.45	14	48
Nov. 1-10	3,209	4.00	.02	.38	20	59
Nov. 11-20	1,958	3.75	.04	.52	32	87
Nov. 21-30	2,194	3.70	.03	.53	28	91
Dec. 1-10	2,014	3.95	.02	.41	19	72
Dec. 11-20	3,116	4.00	.02	.47	18	67
Dec. 21-31	3,670	4.00	.02	.49	17	65
Jan. 1-10, 1947	9,630	4.20	.02	.14	13	39
Jan. 11-20	8,840	4.00	.02	.22	17	46
Jan. 21-31	13,050	4.20	.02	.10	14	35
Feb. 1-10	6,793	4.05	.02	.23	16	45
Feb. 11-20	3,060	3.90	.04	.35	27	79
Feb. 21-28	1,995	3.90	.04	.55	30	98
Mar. 1-10	1,622	3.80	.04	.58	34	110
Mar. 11-20	5,931	4.10	.03	.21	21	67
Mar. 21-31	8,739	4.35	.02	.10	12	37
Apr. 1-10	13,990	4.45	.03	.19	10	35
Apr. 11-20	6,728	4.10	.02	.19	13	41
Apr. 21-30	10,930	4.35	.02	.20	10	35
May 1-10	10,460	4.50	.01	.03	11	32
May 11-20	10,630	4.30	.08	.07	13	40
May 21-31	16,040	4.60	.01	.05	11	32
June 1-10	8,873	4.50	.02	.19	11	41
June 11-20	6,765	4.40	.13	.08	13	41
June 21-30	2,286	4.05	.03	.40	22	73
July 1-10	1,821	3.95	.08	.45	28	95
July 11-20	3,158	4.40	.03	.35	18	66
July 21-31	2,166	4.25	.03	.45	19	66
Aug. 1-10	1,255	4.10	.08	.50	27	88
Aug. 11-20	1,011	4.20	.03	.74	40	114
Aug. 21-31	1,981	4.10	.07	.70	49	140
Sept. 1-10	2,569	4.30	.04	.76	28	82
Sept. 11-20	1,530	4.10	.09	.76	36	105
Sept. 21-30	857	4.00	.12	.78	38	114

* Reported as H^+ - original values were multiplied by ratio of equivalent weights, to obtain figures shown.

EXHIBIT F

Table 25 (continued)

Date	Flow cfs	pH	Fe mg/l	Mn. mg/l	Acid as H_2SO_4* mg/l	SO_4 mg/l
Oct. 1-10, 1947	537	3.60	0.10	0.60	47	147
Oct. 11-20	435	3.60	.34	1.00	64	188
Oct. 21-31	470	3.50	--	--	72	200
Nov. 1-10	1,293	3.45	--	--	64	197
Nov. 11-20	2,692	3.95	--	--	24	80
Nov. 21-30	4,873	3.95	--	--	19	67
Dec. 1-10	4,150	4.00	--	--	--	--
Dec. 11-20	4,984	4.10	--	--	--	--
Dec. 21-31	2,630	3.95	--	--	--	--
Jan. 1-10, 1948	5,312	3.85	.02	.34	20	65
Jan. 11-20	3,191	3.85	--	--	--	--
Jan. 21-31	1,928	3.65	--	--	--	--
Feb. 1-10	1,294	3.65	--	--	35	107
Feb. 11-16	5,940	3.70	--	--	40	113
Feb. 17-20	1,605	4.35	--	--	14	46
Feb. 21-29	13,341	4.10	--	--	16	41
Mar. 1-10	9,601	4.05	--	--	15	43
Mar. 11-20	11,677	4.20	--	--	15	45
Mar. 21-31	15,711	4.10	--	--	10	35
Apr. 1-10	9,196	4.00	.02	.21	14	40
Apr. 11-20	36,668	4.10	--	--	14	42
Apr. 21-30	11,100	3.95	--	--	17	53
May 1-10	12,926	4.10	--	--	13	43
May 11-20	10,432	4.10	--	--	12	40
May 21-31	6,777	4.25	--	--	12	38
June 1-10	2,834	4.15	--	--	20	67
June 11-20	2,927	4.00	--	--	29	90
June 21-30	5,743	4.05	--	--	22	62
July 1-10	2,233	3.95	--	--	28	80
July 11-20	1,891	3.90	--	--	35	102
July 21-31	4,057	4.40	--	--	20	59
Aug. 1-10	1,994	4.10	--	--	29	88
Aug. 11-20	1,595	3.95	--	--	36	109
Aug. 21-31	9,940	3.10	--	--	59	116
Sept. 1-10	528	3.90	.02	1.40	48	157
Sept. 11-20	462	3.80	--	--	92	192
Sept. 21-30	332	3.75	--	--	94	226
Oct. 1-10	359	3.90	.16	1.50	72	250
Oct. 11-20	819	3.50	.15	--	103	243
Oct. 21-31	521	3.65	.14	--	73	172

EXHIBIT F

Table 25 (continued)

Date	Flow cfs	pH	Fe mg/l	Mn. mg/l	Acid as H_2SO_4* mg/l	SO_4 mg/l
Nov. 1-10, 1948	1,194	3.80	--	--	66	171
Nov. 11-20	1,648	3.90	.04	--	66	116
Nov. 21-30	4,413	4.45	--	.62	33	53
Dec. 1-10	4,597	4.50	--	--	94	57
Dec. 11-20	10,090	4.50	--	--	42	41
Dec. 21-31	7,587	4.25	--	--	39	48
Jan. 1-10, 1949	15,370	4.30	--	--	39	38
Jan. 11-20	8,358	4.20	--	--	56	62
Jan. 21-31	17,980	4.20	.04	.23	32	48
Feb. 1-10	7,285	4.20	.00	--	21	52
Feb. 11-15, 18	6,653	4.20	.00	--	24	63
Feb. 16,17,19,20	15,625	4.40	.00	--	12	40
Feb. 21-28	12,140	4.30	.00	--	13	48
Mar. 1-10	7,497	4.30	.00	--	18	52
Mar. 11-20	4,993	4.30	.00	--	18	56
Mar. 21-31	6,245	4.00	.02	--	20	57
Apr. 1-10	11,100	4.30	.01	.05	18	39
Apr. 11-20	9,375	4.40	.02	--	10	34
Apr. 21-30	8,385	4.50	.02	--	8	43
May 1-10	4,266	4.20	.03	--	16	57
May 11-20	2,437	3.90	--	--	30	77
May 21-31	8,170	4.25	--	--	18	43
June 1-10	2,355	3.90	--	--	24	65
June 11-20	1,165	3.60	.15	--	40	96
June 21-30	808	3.40	.30	--	57	135
July 1-10	624	3.20	.45	--	70	174
July 11-20	797	3.30	--	--	68	211
July 21-31	650	3.40	.28	--	56	168
Aug. 1-10	409	3.40	.38	--	62	211
Aug. 11-20	404	3.40	.50	--	74	214
Aug. 21-31	522	3.40	.45	--	64	168
Sept. 1-10	521	3.30	.50	2.00	52	200
Sept. 11-20	422	3.35	--	--	64	207
Sept. 21-30	510	3.30	--	--	60	196
Oct. 1-9, 1950	1,735	3.70	--	--	43	117
Oct. 10-20	12,773	4.20	--	--	14	44
Oct. 21-31	3,304	3.90	--	--	23	67
Nov. 1-4	4,250	3.85	--	--	26	79
Nov. 5-10	24,038	4.25	--	--	12	37
Nov. 11-20	7,172	3.95	--	--	19	51
Nov. 21-30	33,058	3.85	--	--	19	47

EXHIBIT F

Table 25 (continued)

Date	Flow cfs	pH	Fe mg/l	Mn. mg/l	Acid as H_2SO_4* mg/l	SO_4 mg/l
Dec. 1-10, 1950	23,192	3.85	--	--	19	44
Dec. 11-20	7,548	3.85	--	--	32	69
Dec. 21-31	3,826	3.70	--	--	32	91
Jan. 1-4, 1951	5,850	3.80	--	--	30	84
Jan. 5-10	16,783	4.20	--	--	14	43
Jan. 11-20	11,250	4.00	--	--	22	58
Jan. 21-31	14,794	4.40	--	--	25	44
Feb. 1-10	9,900	4.20	--	--	23	50
Feb. 11-20	12,954	4.15	--	--	25	49
Feb. 21-28	21,023	4.35	--	--	21	37
Mar. 1-10	19,856	4.50	--	--	12	32
Mar. 11-20	8,391	4.20	--	--	15	48
Mar. 21-31	13,873	4.30	--	--	15	42
Apr. 1-10	17,330	4.30	--	--	14	37
Apr. 11-20	11,280	4.25	--	--	15	45
Apr. 21-30	9,120	4.30	--	--	13	44
May 1-10	8,218	4.15	--	--	18	53
May 11-20	4,897	4.00	--	--	21	69
May 21-31	4,526	3.95	--	--	25	65

EXHIBIT F

Table 26

TABULATION OF SURVEY RESULTS, 1958-1963
U. S. GEOLOGICAL SURVEY
WEST BRANCH SUSQUEHANNA RIVER AT LOCK HAVEN

Date	Flow cfs	pH	Fe mg/l	Mn. mg/l	Acid as H_2SO_4* mg/l	SO_4 mg/l
Oct. 1-10, 1958	2,960	3.85	---	---	24.5	88
Oct. 11-18	1,480	4.15	---	---	29.4	106
Oct. 19-31, Nov. 1-9	1,680	4.20	0.08	1.3	29.4	121
Nov. 10-20	3,620	4.30	---	---	14.7	72
Nov. 21-30, Dec. 1-6	4,120	4.50	0.00	0.31	9.8	61
Dec. 7-8	5,230	4.30	---	---	14.7	78
Dec. 9-10, 12-21	2,860	4.50	---	---	9.8	64
Dec. 22-31, Jan. 1-4, 1959	2,090	4.25	---	---	14.7	98
Jan. 5	2,700	4.15	---	---	19.6	115
Jan. 6-17	2,060	4.40	---	---	9.8	74
Jan. 18-21	4,610	4.30	---	---	9.8	77
Jan. 22-26	34,800	4.45	---	---	9.8	38
Jan. 27-31, Feb. 1-10	6,320	4.10	---	---	14.7	67
Feb. 11-14	2,140	4.35	---	---	14.7	43
Feb. 15-24	9,090	4.30	---	---	9.8	61
Feb. 25-28, Mar. 1-6	5,550	4.20	---	---	9.8	74
Mar. 7-24	10,500	4.10	---	---	14.7	58
Mar. 25-31, Apr. 1-2	12,100	4.50	0.00	0.41	9.8	43
Apr. 3-8	21,900	4.30	---	---	4.9	42
Apr. 9-17	9,660	4.15	---	---	9.8	59
Apr. 18-22, 24-27	6,630	4.05	---	---	14.7	67
Apr. 23	7,020	4.00	0.00	0.55	29.4	67
Apr. 28-30, May 1-3	25,100	4.30	---	---	9.8	46
May 4-11	9,970	4.00	---	---	14.7	70
May 12-27	4,760	3.75	0.02	0.89	19.6	82
May 28-31, June 1-6	2,350	3.80	---	---	19.6	99
June 7-26	1,510	3.70	---	---	29.4	129
June 27-30, July 1-2	2,010	4.00	---	---	14.7	80
July 3-10	1,330	3.85	---	---	24.5	115
July 11-26	806	3.65	---	---	34.3	161
July 27-31, Aug. 1	716	3.70	---	---	39.2	211
Aug. 2-6	597	3.45	---	---	53.9	236
Aug. 8-17	511	3.50	---	---	44.1	202

* Reported as H^+ - original values were multiplied by ratio of equivalent weights, to obtain figures shown.

EXHIBIT F

Table 26 (continued)

Date	Flow cfs	pH	Fe mg/l	Mn. mg/l	Acid as H_2SO_4* mg/l	SO_4 mg/l
Aug. 18-24, 1959	626	3.30	0.33	2.6	58.8	236
Aug 25-28	909	3.60	---	---	34.3	141
Aug. 29-31, Sept. 1-18	601	3.60	---	---	44.1	206
Sept. 19-30	248	3.45	0.33	3.0	53.9	250
July 1-10, 1960	1,670	3.85	0.07	1.6	34.3	128
Aug. 1-10	1,092	3.60	0.19	2.6	44.1	186
Sept. 1-10	360	3.50	0.34	3.2	49.0	258
Oct. 1-10	399	3.50	0.23	2.8	53.9	242
Nov. 1-10	708	3.60	0.14	3.1	107.8	280
Nov. 17	699	3.50	0.04	2.7	39.2	202
Dec. 1-10	504	3.90	0.11	2.4	39.2	194
Jan. 1-10, 1961	524	4.05	0.10	2.6	44.1	214
Feb. 1-4, 6-10	615	3.90	0.09	1.5	29.4	146
Mar. 1-10	21,110	4.30	0.00	0.4	9.8	54
Apr. 1-10	7,009	4.20	0.06	0.4	24.5	67
May 1-10	7,102	4.10	0.06	0.8	19.6	81
June 1-10	2,518	3.90	0.06	1.3	24.5	105
July 1-10	1,758	3.75	0.12	1.2	24.5	115
Aug. 1-10	2,688	3.80	0.04	1.6	19.6	121
Sept. 1-10	1,195	3.70	0.13	2.2	39.2	164
Oct. 1-10	499	3.55	0.27	3.3	58.8	242
Nov. 2-10	697	3.55	0.48	3.1	58.8	265
Dec. 1-10	1,838	4.20	0.01	0.9	14.7	99
Jan. 1-8, 1962	2,602	4.25	0.02	0.95	14.7	95
Feb. 1-6, 8-10	3,743	4.30	0.02	0.89	14.7	74
Mar. 7-10	4,080	4.25	0.00	0.96	19.6	76
Apr. 1-10	24,350	4.15	0.02	0.45	9.8	46
May 1-10	5,171	4.15	0.02	0.88	9.8	80
June 1-4	1,377	4.35	0.00	0.86	14.7	114
July 1-10	414	3.75	0.17	0.95	44.1	206
Aug. 1-10	382	3.75	0.17	1.0	49.0	246
Sept. 1-2, 5-10	495	3.65	0.92	3.4	63.7	279
Oct. 1-10	2,077	4.10	0.04	2.1	29.7	132
Nov. 1-5, 7-10	1,745	4.00	0.05	2.0	29.7	143
Dec. 3-9	1,494	4.40	0.02	1.4	14.7	98
Jan. 1, 2, 7-9, 1963	960	4.35	0.02	1.1	19.5	104
Mar. 1-10	3,858	4.25	0.04	1.2	19.5	110

EXHIBIT F

Table 27

TABULATION OF SURVEY RESULTS
NEW YORK AND PENNSYLVANIA COMPANY
WEST BRANCH SUSQUEHANNA RIVER AT STATION SEVEN
(Below the confluence of North Bald Eagle Creek)

Date	Survey Number	Flow cfs	pH	Alkalinity as $CaCO_3$ mg/l
09-19-62	45	423	6.8	15
08-08-62	44	610	7.1	29
07-05-62	43	681	7.1	19
06-06-62	42	1,790	6.8	17
09-27-61	41	655	7.6	15
08-23-61	40	1,800	6.7	10
07-19-61	39	1,580	6.6	5
06-21-61	38	3,270	6.4	10
08-23-60	37	795	7.1	31
07-21-60	36	2,940	6.6	7
06-31-60	35	5,780	6.3	10
09-23-59	34	435	7.7	41
08-19-59	33	515	7.1	27
07-22-59	32	1,185	7.0	10
09-20-58	31	1,668	6.7	13
08-21-58	30	2,560	6.2	13
08-28-57	29	435	6.9	38
07-25-57	28	1,285	7.5	29
09-27-56	27	2,560	6.7	10
08-30-56	26	3,830	6.5	10
07-26-56	25	5,750	6.1	6
06-28-56	24	9,340	5.6	5
10-14-54	18	980	5.9	20
09-14-54	17	435	7.4	32
08-11-54	16	1,015	5.0	9
07-08-54	15	2,590	5.3	6
06-21-54	14	2,710	6.2	6
10-29-53	13	485	7.2	20
09-25-53	12	733	6.6	12
08-26-53	11	360	7.0	21
07-21-53	10	940	6.9	16
06-23-53	9	1,920	6.6	11
09-28-50	4	1,470	6.2	8
08-30-50	3	1,205	6.6	13
07-20-50	2	2,240	6.8	9

EXHIBIT F

Table 28

BITUMINOUS SURVEY RESULTS
PENNSYLVANIA DEPARTMENT OF HEALTH
WEST BRANCH SUSQUEHANNA AT WILLIAMSPORT

Date	Flow cfs	pH	Alk. as $CaCO_3$ mg/l	Acid as $CaCO_3$ mg/l	Fe mg/l	SO_4 mg/l
03-22-50	12,200	6.3	12	4	0.6	47
05-24-50	10,300	5.6	5	4	0.3	45
07-19-50	2,040	6.5	8	0	0.4	56
10-13-50	1,240	7.4	12	0	0.2	112
02-20-51	17,600	6.2	10	4	1.25	41
04-10-51	12,500	6.3	7	0	0.5	38
06-05-51	3,300	6.3	16	2	0.3	87
08-15-51	1,280	6.8	28	2	0.3	98
10-16-51	530	6.3	22	16	0.4	150
11-25-51	3,950	6.2	12	8	0.5	72
02-27-52	4,290	6.1	12	6	0.5	79
04-30-52	8,900	6.2	9	4	0.2	38
07-01-52	1,300	7.5	24	0	3.2	80
09-11-52	820	6.7	34	0	0.3	104
10-23-52	630	6.4	24	0	0.4	145
12-16-52	11,500	5.2	10	0	0.5	29
02-24-53	16,600	6.0	4	0	2.5	29
04-22-53	12,200	5.5	4	4	1.2	41
06-25-53	2,500	6.0	19	0	0.4	76
09-22-53	950	6.4	16	0	0.0	89
03-12-54	10,200	5.6	7	6	1.0	43
07-20-54	1,400	6.3	14	4	0.1	85
10-13-54	1,360	4.4	13	42	0.1	250
07-14-55	2,330	6.3	15	0	0.4	75
11-02-55	9,000	5.9	29	2	0.4	36
06-10-58	9,710	6.5	13	0	0.6	76
07-22-58	5,420	5.4	4	4	1.8	59
08-13-58	4,480	6.4	10	0	1.0	68
09-09-58	6,160	7.7	18	0	0.2	76
02-02-59	8,800	5.5	3	4	0.5	38
07-29-59	1,110	6.64	18	2	0.0	76
08-26-59	1,660	6.62	26	4	0.0	108
11-18-59	6,090	6.4	10	0	1.1	46
03-24-60	2,900	6.3	14	2	6.1	69
06-13-60	6,330	6.13	14	2	0.0	41
09-01-60	866	6.2	28	6	2.2	82

EXHIBIT F

Table 29

TABULATION OF WATER QUALITY NETWORK RESULTS
PENNSYLVANIA DEPARTMENT OF HEALTH
WEST BRANCH SUSQUEHANNA RIVER AT WILLIAMSPORT AND RENOVO

Date	Flow cfs	Field D.O. mg/l	Field pH	Alk. as $CaCO_3$ mg/l	Acid as $CaCO_3$ mg/l	BOD mg/l	Fe mg/l	Mn. mg/l	So_4 mg/l
West Branch Susquehanna River near Williamsport									
05-25-62	4,350	8.4	6.0	9	2	0.5	0.1	1.25	68
08-17-62	920	9.0	6.8	28	0	0.3	0.4	1.00	142
11-09-62	2,970	13.6	5.4	10	2	0.4	0.1	1.25	106
05-17-63	5,530	8.4	6.2	9	0	0.8	0.2	--	60
08-23-63	1,067	9.2	6.8	24	0	0.5	0.0	1.3	220
11-15-63	1,368	12.8	5.4	4	40	0.9	0.0	2.0	210
02-07-64	7,330	12.8	5.6	6	2	1.6	0.8	0.6	62
West Branch Susquehanna River near Renovo									
05-24-62	2,180	8.0	3.6	0	18	1.1	0.3	1.7	92
08-16-62	462	8.0	3.2	0	105	0.5	0.8	3.0	320
11-09-62	1,520	13.2	3.8	0	--	0.2	0.6	--	--
05-22-63	5,866	10.3	4.6	5	14	2.7	0.6	0.6	50
08-12-63	567	5.0	3.5	0	82	1.2	0.2	3.5	305
11-15-63	757	10.6	3.6	0	40	3.4	1.0	2.6	190
02-07-64	3,540	14.6	5.0	33	20	1.2	1.0	--	150

POTTER
TIOGA
BRADF
ELK
CAMERON
LYCOMING
SULLIV
CLINTON
CLEARFIELD
CENTRE
UNION
SNYDER
MONTOUR
NORTHUMBERLAND
COL
CAMBRIA
EMPORIUM
STEVENSON DAM
ALVIN R. BUSH RESERVOIR
RENOVO
WILLIAMSPORT
JERSEY SHORE
LOCK HAVEN
BEECH CREEK
MILL HALL
BLANCHARD
PROPOSED BLANCHARD RESERVOIR
CLEARFIELD
CURWENSVILLE
CURWENSVILLE DAM
MILESBURG
BELLEFONTE
STATE COLLEGE
MILTON
LEWISBURG
NORTHUMBERLAND
SUNBURY
SUSQUEHANNA RIVER
SCALE in MILES
0
10
20
30
40

WAT

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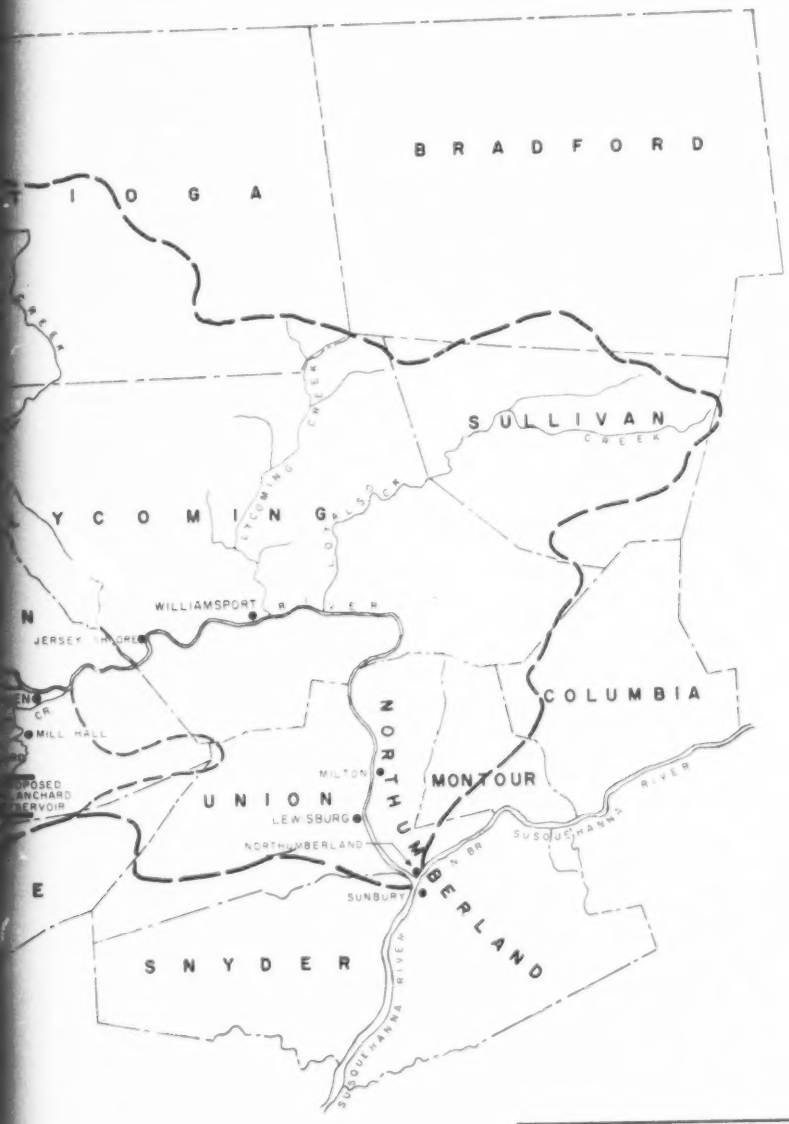
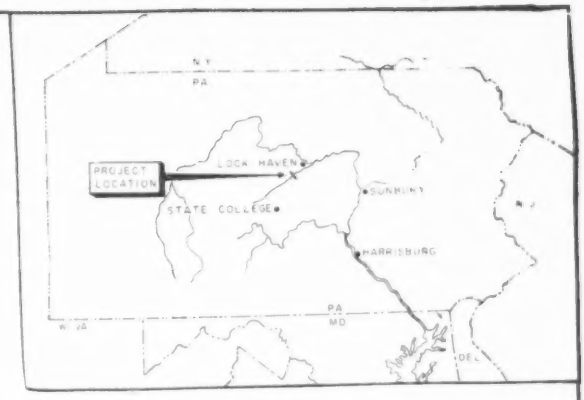




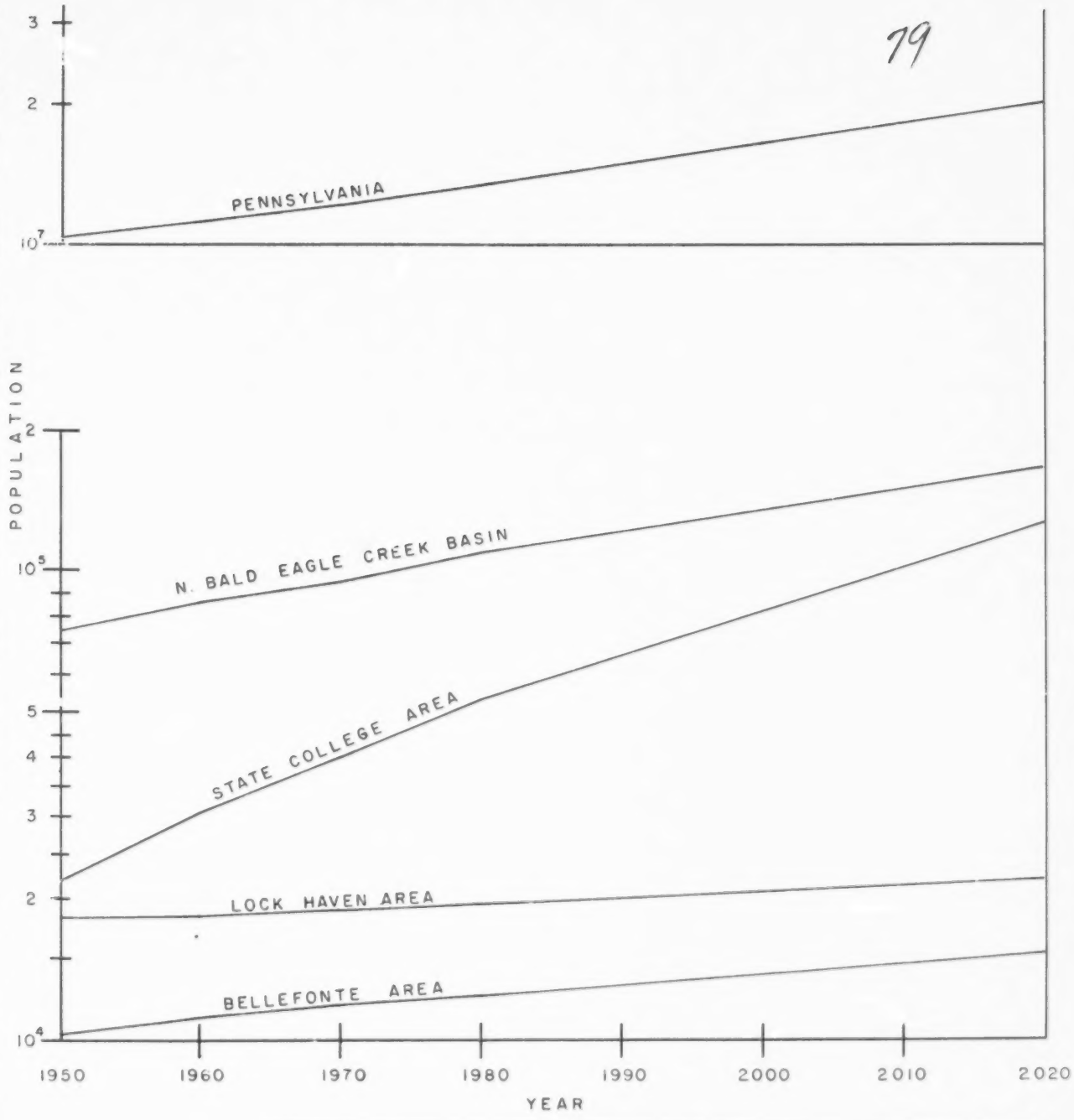
LOCATION MAP

WATER SUPPLY AND WATER QUALITY CONTROL STUDY
BLANCHARD RESERVOIR, PENNSYLVANIA

MAP OF STUDY AREA

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION III CHARLOTTESVILLE, VIRGINIA

FIGURE 1



WATER SUPPLY AND WATER QUALITY CONTROL STUDY
BLANCHARD RESERVOIR, PENNSYLVANIA

POPULATION TRENDS & PROJECTIONS
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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
REGION III CHARLOTTESVILLE, VIRGINIA

FIGURE 2